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FOUR SPECIES OF DIGENEANS (TREMATODA, OPECOELIDAE) OF THE GILTHEAD SEABREAM *SPARUS AURATA* (TELEOSTEI, SPARIDAE) OFF THE ALGERIAN COAST IN THE MEDITERRANEAN SEA

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Four Species of Digeneans (Trematoda, Opecoelidae) of the Gilthead Seabream *Sparus aurata* (Teleostei, Sparidae) off the Algerian Coast in the Mediterranean Sea. Zedam, F.-Z., Boukadoum, A. & Tazerouti, F. — A study was conducted between May 2020 and April 2022, in an attempt to investigate the diversity of digeneans infecting the digestive tract of the gilthead sea bream *Sparus aurata* (Linnaeus, 1758) (Sparidae) off the Algerian coast. Four species belonging to the family Opecoelidae Ozaki, 1925 were collected: *Macvicaria obovata* (Molin, 1859) Bartoli, Bray & Gibson, 1989; *Macvicaria maillardi* Bartoli, Bray & Gibson, 1989; Bartoli & Gibson, 2007; *Macvicaria maamouriae* Antar, Georgieva, Gargouri & Kostadinova, 2015 and *Allopodocotyle pedicellata* (Stossich, 1887) Pritchard, 1966. Algeria is a new geographical record for *M. obovata* and *A. pedicellata*, whereas *M. maillardi* has already been reported on the Algerian coast, but not from its type host *S. aurata*. In this paper, we provide a redescription of these species based on newly collected specimens which were identified using only morphological features such as the distribution of vitelline follicles and, uterus, the position and shape of the cirrus-sac, and the presence or absence of the metraterm. We also highlighted the morphometric variations between our specimens and those described. We also highlighted the intraspecific morphometric variation in comparison with published data. The epidemiological indices show that *M. obovata* has the highest values in both prevalence and abundance (33.3 % and 2.2 %, respectively).
Key words: Digenea, Algerian coast, Mediterranean Sea, Allopodocotyle, Macvicaria, Opecoelidae, Sparidae, *Sparus aurata*.

Introduction

The Sparidae is one of the most important families of marine fish with high biological diversity and ecological importance, widely distributed in temperate and tropical waters (Rima et al., 2017). The gilthead sea bream, *Sparus aurata* Linnaeus, 1758 is a teleost of great economic interest and widespread worldwide, especially in the Mediterranean (Mahmoud et al., 2014).

The digeneans fauna of this fish host has been the focus of numerous studies the northern coasts of the Western Mediterranean (Bartoli, 1987 a, b; Bartoli & Gibson, 1989; Bartoli & Bray, 1996; Sasal et al., 1999; Ternengo et al., 2005; Pérez-del Olmo et al., 2006, 2007 a; Kostadinova & Gibson, 2009; Sánchez-García et al., 2014). However, fewer studies haves been carried out along the southern coasts of the Western Mediterranean (Abdallah & Maamouri, 2008; Abdallah et al., 2011; Derbel et al., 2012; Bayoumy & Abu-Taweel, 2012; Antar & Gargouri, 2013; Antar et al., 2015) and especially, along the Algerian coast, since just a single study was carried out by Rima et al. (2017) to investigate the digeneans parasites of *S. aurata*.

Therefore, we provide here morphological descriptions of four species, discuss their taxonomic status, host specificity, and distribution, and analyse the ecological data to assess the species diversity of the digeneans infecting the gilthead seabream in Algeria.

Material and methods

A total of 33 *Sparus aurata* were collected along the Algerian coast in Oran (35°42'36.7" N, 0°38'46.3" W) (fig. 1). During the sampling period between May 2020 and April 2022. Fishes were brought to the laboratory immediately after capture and identified using the keys of Fisher et al. (1987). The digestive tract was removed from each fish and observed under a stereomicroscope (Carl Zeiss™ 2000 Stereomicroscope, Germany) for the presence of digenetic trematodes. Using fine dissection needles, digeneans were removed alive, slightly flattened between cover slip and glass slide, fixed in 70 % ethanol with Bouin's fluid, stained with boracic carmine, dehydrated in ethanol series (70, 96 and 100 %), cleared in clove oil, and mounted in Canada balsam. Drawings were made with the aid of a Leitz microscope equipped with a drawing tube (Leitz, Wetzlar, Germany); these were scanned and redrawn with Adobe Illustrator (CS5). Measurements are in micrometers with the minimum and maximum in parentheses followed by the mean values and standard deviation. The parasitological indices, the prevalence (P, %), mean intensity (MI), and abundance (A) were calculated as defined by (Bush et al., 1997). In addition, digenean species were classified based on their prevalence into core (prevalence ≥ 66.6 %), secondary (33.3 % < prevalence < 66.6 %) and satellite species (prevalence ≤ 33.3 %) (Bush & Holmes, 1986).

Fig. 1. Collection sites of *Sparus aurata* from Oran, Algeria.

Table 1. Parasitological indices' prevalence (P, %), mean intensity (MI), and mean abundance (A) of the opecoelid digenean species recovered from *Sparus aurata* in the present study

Host	Family of parasite	Species	NNP	P, %	A	MI
Sparus aurata Linnaeus, 1758	Opecoelidae Ozaki, 1925	*Allopodocotyle pedicellata* (Stossich, 1887) Pritchard, 1966	445	15. 15	1. 36	9
		*Macvicaria obovata (*Molin, 1859) Bartoli, Bray & Gibson, 1989	773	33. 33	2. 21	6. 63
		Macvicaria maillardi Bartoli, Bray & Gibson, 1989	282	18. 18	0. 8	4.66
		Macvicaria maamouriae Antar, Georgieva, Gargouri & Kostadinova, 2015	332	3. 84	1. 23	32

Results

Out of the examined 33 individuals of *S. aurata*, 69.7 % were found infested. A total of 178 digenean individuals-belonging to two genera of the family Opecoelidae Ozaki, 1925, *Allopodocotyle* Pritchard, 1966 and *Macvicaria* Gibson & Bray, 1982, were recovered from the digestive tract: *Allopodocotyle pedicellata* (Stossich, 1887) Pritchard, 1966; *Macvicaria obovata* (Molin, 1859) Bartoli, Bray & Gibson, 1989; *Macvicaria maillardi* Bartoli, Bray & Gibson, 1989 and *Macvicaria maamouriae* Antar, Georgieva, Gargouri & Kostadinova, 2015 (table 1).

Genus *Allopodocotyle* Pritchard, 1966
Allopodocotyle pedicellata (Stossich, 1887) Pritchard, 1966

Host. *Sparus aurata* (Linnaeus, 1758)
Locality. Algerian coast in Oran.
Site on host. Intestine.
Records in the Mediterranean. Ex *S. aurata*, off the Adriatic Sea, Trieste; (Stossich, 1887, 1898; Barbagallo & Drago, 1903); Janiszewska, 1953; Maillart, 1976; Papoutsoglou, 1976; Saad Fares, 1985; Bartoli et al., 1989) off Corsica (Bartoli et al., 1989), off silica (Barbagallo & Drago, 1903) and off Tunisia (Derbel et al., 2012; Antar & Gargouri, 2018); ex *Diplodus puntazzo* (Walbaum, 1792), off Saronic Gulf (Papoutsoglou, 1976); ex *Pagrus caeruleostictus* Valenciennes, 1830; ex *Oblada melanura* Linnaeus, 1758, off Lebanon (Saad Fares, 1985); ex *Pagrus pagrus* Linnaeus, 1758, off the Aegean Sea (Akmirza, 2000). This is the first record on Algeria's coast (fig. 2).

Description

[Based on 20 whole-mounted gravid specimens; fig. 3 ; measurements in table 2]

Body elongate-oval, rounded at both ends. Forebody and hindbody occupying 18–27 (24.8) % and 48–76 (60) % of body length, respectively (fig. 3, A). Tegument thick, lacking spines. Oral sucker ventro-subterminal, oval with a sub ventral opening. Ventral sucker in the anterior third of body, rounded, always protuberant, as a result, all specimens are mounted laterally. The latter is bigger than the oral sucker. Oral sucker to ventral length ratio 1 : 1.4–1.6 (1.5), widthratio 1 : 1.15–1.4 (1.2). Pre-pharynx distinct, long, thick-walled. Pharynx large, muscular, subcylindrical. Oesophagus long, bifurcating at the level of the ventral sucker; caeca wide, terminate blindly in posterior body third. Testes 2, elongate oval, entire, tandem, contiguous, post-ovarian, in

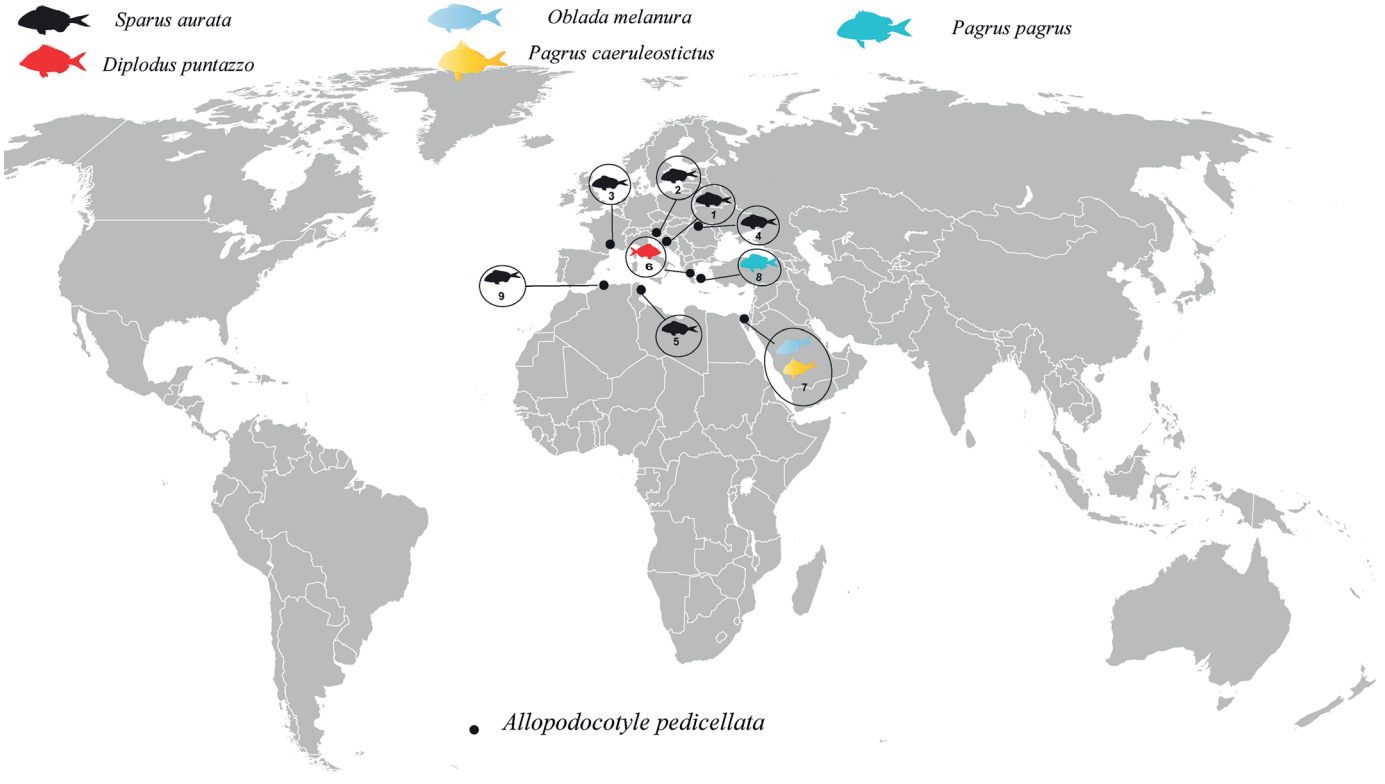
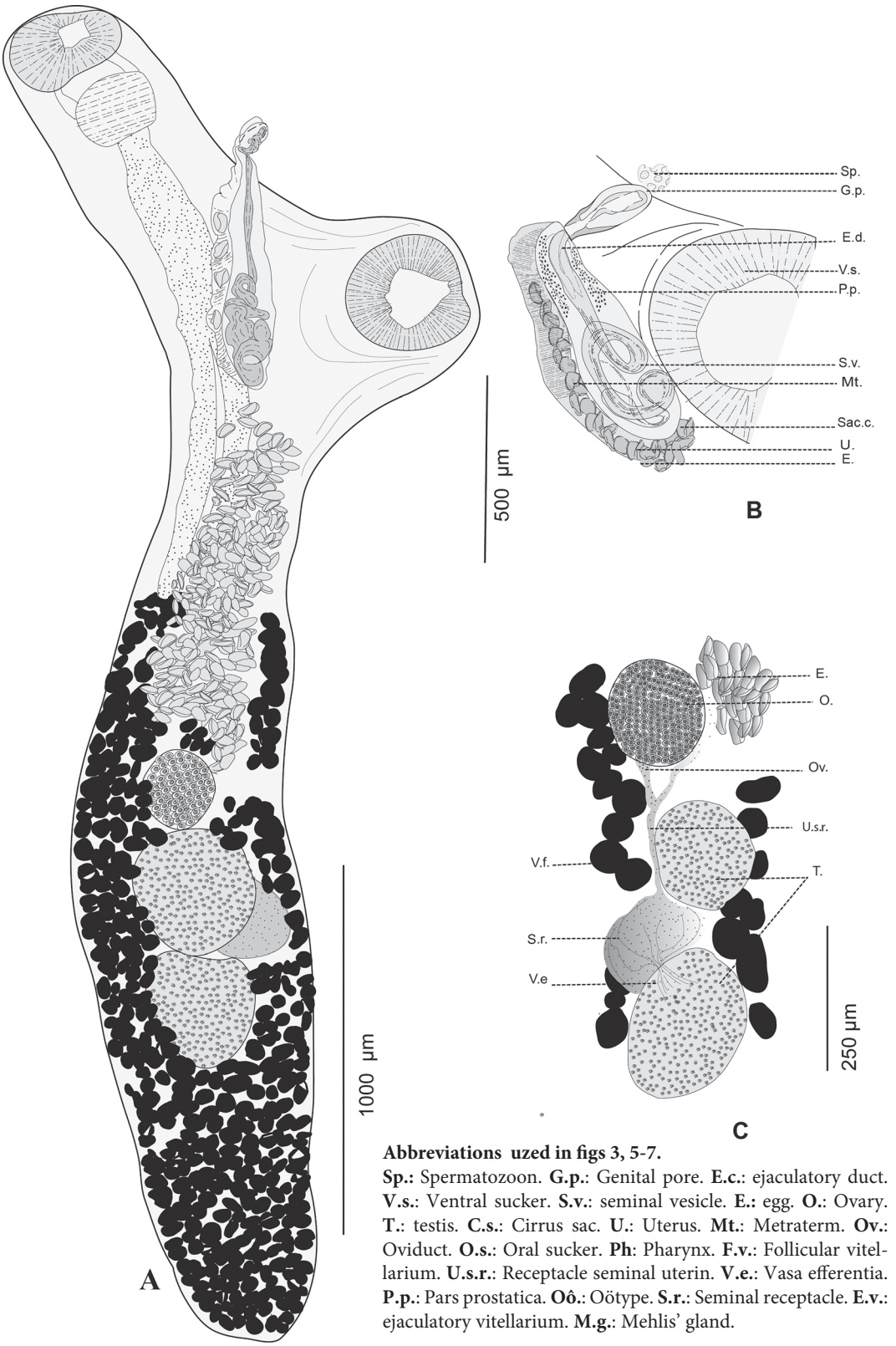


Fig. 2. Geographical distribution of *Allopodocotyle pedicellata* (Stossich, 1887) Pritchard, 1966 from fish around the world. References for the records are given between parentheses.

Table 2. Measurements of *Allopodocotyle pedicellata* (Stossich, 1887) Pritchard, 1966 from *Sparus aurata* in different localities

Hosts	*Sparus aurata* (Intestine)				
Locality	Off Algeria	Off Corsica, France	Montenegro	Adriatic Sea	Gulf of Lion
Source	Present study	Bartoli et al. (1989)	Radujkovié et al. (1989)	Janiszewska (1953)	Bartoli (1987)
Body length	2382–5475 (3886 ± 1919 n = 20)	2,425–6,015 (3,920)	4900–6230	2.5–4.5 mm	3931–6014 (5083)
Width of the body at ovary level	410–938 (749 ± 177, n = 20)	425–1,170 (665)	820–1270	0.36–0.6 mm	722–786 (748)
Forebody length	430–1494 (964 ± 322, n = 20)	680–1,805 (1,100)	–	–	1084–1700 (1356)
Hindbody length	1152–4168 (2335 ± 1166, n = 20)	1,275–4,250 (2,400)	–	–	2486–4250 (3400)
Oral sucker length	183–332 (271 ± 46, n = 20)	190–415 (320)	370–400	0.16 x 0.14	330–416 (356)
Oral sucker width	228–443 (336 ± 75, n = 20)	245–455 (345)	380–450	0.2x 0.16 mm	346–453 (393)
Ventral sucker length	257–539 (408 ± 92, n = 20)	280–580 x (435)	500–620	0.2 x 0.3	426–581 (484)
Ventral sucker width	256–632 (403 ± 91, n = 20)	320–650 (460)	450–630	0.28 x 0.48	437–650 (540)
Prepharynx length	23–131 (70 ± 29, n = 20)	53–135 (84)	–	-	96–33 (108)
Pharynx length	75–274 (220 ± 50, n = 20)	96–350 (240)	280–340	0.12 x 0.08 mm	197–325 (265)
Pharynx width	159–335 (280 ± 48, n = 20)	165–400 (260)	240–330	0.14 x 0.12	288–309 (300)
Esophagus length	100–502 (184 ± 121, n = 19)	69–115 (96)	–		69–117 (96)
Cirrus-sac length	237–468 (285 ± 117, n = 16)	480–1 200	770–980		645–1199 (838)
Anterior testis length	222–498 (379 ± 86, n = 20)	190–560×175–535 (330 x 320)	420–600×410– 580	0.12 x 0.16 mm	240–560 (408)
Anterior testis width	204–518 (359 ± 74, n = 20)	–	–	0.13 x 0.24	309–533 (427)
Posterior tests length	185–499 (357 ± 102, n = 20)	230–640×205–585 (360×320)	–	0.12 x 0.18 mm	288–640 (480)
Posterior tests width	180.21–486.59 (346 ± 94, n = 20)	–	0.16×0.21		282–586 (414)
Ovary length	135–312 (230 ± 59, n = 20)	135–345 (205)	240–310	0.8 x 0.13 mm	176–346 (271)
Ovary width	99–311 (215±61, n=20)	96–265 (175)	200–290	0.13 x 0,16	176–266 (225)
Seminal receptacle	–	80–345×50-240 (215×120)		–	
Egg lengths	39–72 (60±11, n=16)	59–69×(62)	70–80×43–60	0.039 mm	59–69 (65)
Egg widths	32.94–60.45 (47±9, n=16)	33–43 (35)		0.056	
Sucker width ratio	1:1.15–1.42 (1,28)	1:1.01–1.63 (1.35)	–	–	1/.47–1/1.27 (1/1.35)
Oral sucker/pharynx width ratio	1:1.61–1.88 (1.74)	1:0.56–0.85 (0.74)	–	–	1/0.85–1/0.62 (1/0.73)–1/0.85–1/0.62 (1/0.73)
Forebody to hindbody ratio	1:0.37–0.35 (0.36)	1:1.52–3.85 (2.04)	–	–	1/3.22–1/2.27 (1/2.43)



Abbreviations uzed in figs 3, 5-7.
Sp.: Spermatozoon. **G.p.**: Genital pore. **E.c.**: ejaculatory duct. **V.s.**: Ventral sucker. **S.v.**: seminal vesicle. **E.:** egg. **O.**: Ovary. **T.**: testis. **C.s.**: Cirrus sac. **U.**: Uterus. **Mt.**: Metraterm. **Ov.**: Oviduct. **O.s.**: Oral sucker. **Ph**: Pharynx. **F.v.**: Follicular vitellarium. **U.s.r.**: Receptacle seminal uterin. **V.e.**: Vasa efferentia. **P.p.**: Pars prostatica. **Oô.**: Oötype. **S.r.**: Seminal receptacle. **E.v.**: ejaculatory vitellarium. **M.g.**: Mehlis' gland.

Fig. 3. *Allopodocotyle pedicellata* (Stossich, 1887) ex *Sparus aurata*: A — body, ventral views; B — ventral view of the male genitalia; C — dorsal view of the female genitalia.

mid-hindbody. Cirrus- sac present, curved, dorsal to ventral sucker, containing tubular convoluted internal seminal vesicle, pars prostatica with numerous large prostatic cells, muscular ejaculatory duct, and cirrus with granular surface. Genital pore anterior the ventral sucker (fig. 3, B). Ovary rounded, entire, often contiguous with anterior testis, in mid hindbody, pre-testicular; oviduct short, with thickened wall. Seminal receptacle large, sometimes larger than ovary. Uterus exclusively pre-testicular, filled with eggs, coiled between ventral sucker and ovary, ending with metraterm (fig. 3, C). Vitellarium follicular, vitelline follicles numerous, extending from mid-length between ventral sucker and ovary to posterior extremity; vitelline fields, confluent both dorsally and ventrally in the post-testicular region. Eggssmall, oval.

Genus *Macvicaria* Gibson & Bray, 1982
Macvicaria obovata (Molin, 1859) Bartoli, Bray & Gibson, 1989

Host. *Sparus aurata* (Linnaeus, 1758)
Locality. Algerian coast in Oran.
Site on host. Intestine.
Records in the Mediterranean. Ex *S. aurata*, off Var, Provence, France, Sanary (Maillard, 1976; Fischthal, 1980; Bray, 1987; Bartoli et al., 1989) Italy (Molin, 1859, 1861) and off Tunisia (Gargouri Ben Abdallah et al., 2011; Derbel et al., 2012; Antar & Gargouri, 2018). This is the first record on Algeria's coast (fig. 4).

Description

[Based on 20 whole-mounted gravid specimens; fig. 5; measurements in table 3]

Body elongate oval, rounded at both ends; lateral margins almost parallel, slightly narrowed at the level of ventral sucker. Forebody and hindbody long, occupying 27–31 (28.5) % and 50.6–55.8 (53.6) % of body length, respectively (fig. 5, B). Tegument thick, unarmed. Oral sucker transversely-oval, ventro-subterminal. Ventral sucker oval, pre-equatorial, with transverse slit-like opening, the main axis of which is transverse; muscle fibres powerful, radiate from lateral edges of ventral sucker, ventral sucker is bigger than the oral sucker. Prepharynx present, short. Pharynx well-developed, elongate-oval. Esophagus occasionally present; short. Intestinal bifurcation in mid-forebody, anterior to ventral sucker. Caeca thin-walled, with wide lumen, terminate blindly close to the posterior extremity of the body. Testes 2, tandem, contiguous, post-ovarian, transversely- oval, entire, in midhindbody. Cirrus-sac present, claviform, curved, narrower anteriorly, wider posteriorly, sinistral at level of ventral sucker, containing tubular, convoluted internal seminal vesicle, sphincter, separating seminal vesicle from muscular pars prostatica (fig. 5, B) and muscular**.** Ejaculatory duct, located in the proximal part of cirrus-sac. Genital pore, at mid-length between ventral sucker and pharynx. Ovary Spherical to oval, entire, sinistral, just posterior to ventral sucker, pre-testicular; oviduct short. Seminal receptacle voluminous, posterior to ovary. Oötype surrounded by Mehlis' gland (fig. 5, C). Uterus coiled between anterior testis and ovary, ending with metraterm. Metraterm muscular, runs along right edge of cirrus-sac, opens into genital atrium. Vitellarium follicular, in 2 lateral fields interrupted at level of ventral sucker, confluent in post-testicular region. Eggs large, operculate,without filaments.

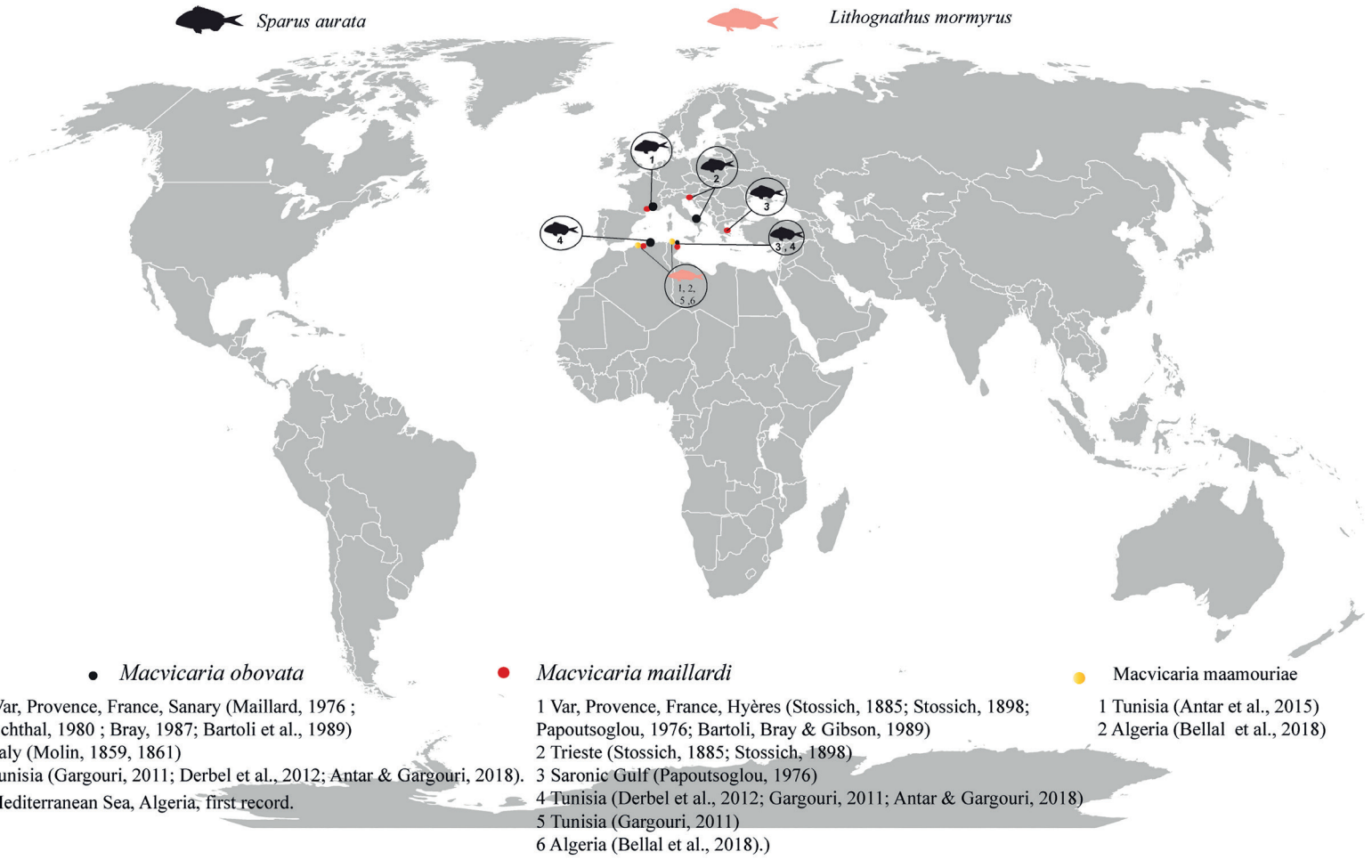


Fig. 4. Geographical distribution of three species of *Macvicaria: M. obovata* (Molin, 1859) Bartoli, Bray and Gibson, 1989; *M. maillardi* Bartoli, Bray and Gibson, 1989 and *M. maamouriae* Antar, Georgieva, Gargouri et Kostadinova, 2015 from fish around the world. References for the records are given between parentheses.

Table 3. Comparison of morphometric data of *Macvicaria obovata* (Molin, 1859) Bartoli, Bray & Gibson, 1989

Hosts	*Sparus aurata*	
Locality	Off Algeria	Off France
Source	Present study	(Bartoli et al., 1989)
Body length	2,038–3,931 (2,914 ± 1,444, n = 20)	2,359–4,951 (3,583 ± 1,250)
Width of the body at the ovary	411–1,263 (1,042 ± 200, n = 20)	786–1,743 (1,266 ± 444)
Forebody	548–1223 (43830 ± 178, n = 20)	829–2,061 (1,329 ± 618)
Hindbody	1031–2192 (1563 ± 279, n = 20)	914–2,508 (1,702 ± 948)
Oral sucker length	169–204 (338 ± 402, n = 20)	192–501 (362 ± 134)
Oral sucker width	299–504 (408 ± 63, n = 20)	309–720 (473 ± 130)
Ventral sucker length	415–614 (521 ± 59, n = 20)	384–757 (541 ± 158)
Ventral sucker width	474–773 (653 ± 104, n = 20)	549–959 (674 ± 214)
Prepharynx	22–87 (56 ± 18, n = 17)	32–187 (93 ± 39)
Pharynx length	158–296 (217 ± 37, n = 20)	113–346 (262 ± 108)
Pharynx width	199–354 (301 ± 44, n = 20)	240–549(364 ± 148)
Esophagus	43–186 (84 ± 32, n = 17)	53–165 (100 ± 33)
Anterior testis length	170–393 (303 ± 56, n = 20)	133–352 (245 ± 124)
Anterior testis width	244–656 (432 ± 101, n = 20)	282–789 (494 ± 130)
Posterior testis length	155–376 (270 ± 59, n = 20)	187–416 (294 ± 114)
Posterior testis width	206–588 (444 ± 92, n = 20)	261–720 (450 ± 220)
Ovary length	134–267 (205 ± 32, n = 20)	160–378 (257± 104)
Ovary width	143–340 (225 ± 46, n = 20)	176–346 (259± 48)
Egg length	31–97 (52 ± 21, n = 19)	65–78 (70 .5 ± 6)
Egg width	30–97 (59 ± 18, n = 19)	30–41 (35 .1 ± 5)
Sucker ratio	1 : 0.63–0.65	1 : 1. 26–2. 04 (1.5)
Oral sucker/pharynx ratio	1 : 1.50–1.42	1 : 0 51–0 86 (0.72)
Oral sucker/pharynx Width ratio	1 : 1.2–1.3(1.25)	–
Forebody/Hindbody ratio	0 : 0.53–0.5 (1)	–

Macvicaria maillardi Bartoli, Bray & Gibson, 1989

Host. *Sparus aurata* Linnaeus, 1758

Locality. Algerian coast in Oran.

Site on host. Intestine.

Records in the Mediterranean. Ex *S. aurata*, off Var, Provence, France, Hyères (Stossich, 1885; Stossich, 1898; Papoutsoglou, 1976; Bartoli et al., 1989) off Trieste (Stossich, 1885; Stossich, 1898) off France (Bartoli et al., 1989) off Saronic Gulf (Papoutsoglou, 1976) off Tunisia (Derbel et al., 2012; Gargouri, 2011; Antar & Gargouri, 2018) and ex *Lithognathus mormyrus* (Linnaeus, 1758) off Tunisia (Gargouri, 2011) and off Algeria (Bellal et al., 2018) (fig. 4).

Description

[Based on 20 whole-mounted gravid specimens; fig. 6; measurements in table 4]

Body elongate oval, rounded at both ends; lateral margins parallel. Forebody and hindbody long, occupying 27–30 (31,4) % and 54–55 (55,9) % of body length, respectively (fig. 6, A). Tegument thick, unarmed. Oral sucker transversely oval, subterminal, opens anteroventrally. Ventral sucker transversely oval, pre-equatorial, with a transverse slit-like opening, with the major axis transverse; surrounded by several indistinct tegumental folds; numerous muscle fibres radiate from the lateral edges of the sucker to the edges of the body. Ventral sucker is bigger than oral sucker. Prepharynx present, short. Pharynx well-

developed, large. Esophagus when observed short. Intestinal bifurcation in the mid of the forebody, pre-acetabular. Caeca with thin wall and wide lumen, terminates in the hindbody near the posterior end. Two testes round to transversely oval, entire, tandem, separated, in the anterior half of hindbody, post ovarian. Cirrus-sac present, claviform; dorsal to ventral sucker. In its distal part, internal seminal vesicle tubular and convoluted; in its proximal part, short pars prostatica and muscular ejaculatory duct that opens directly throught a

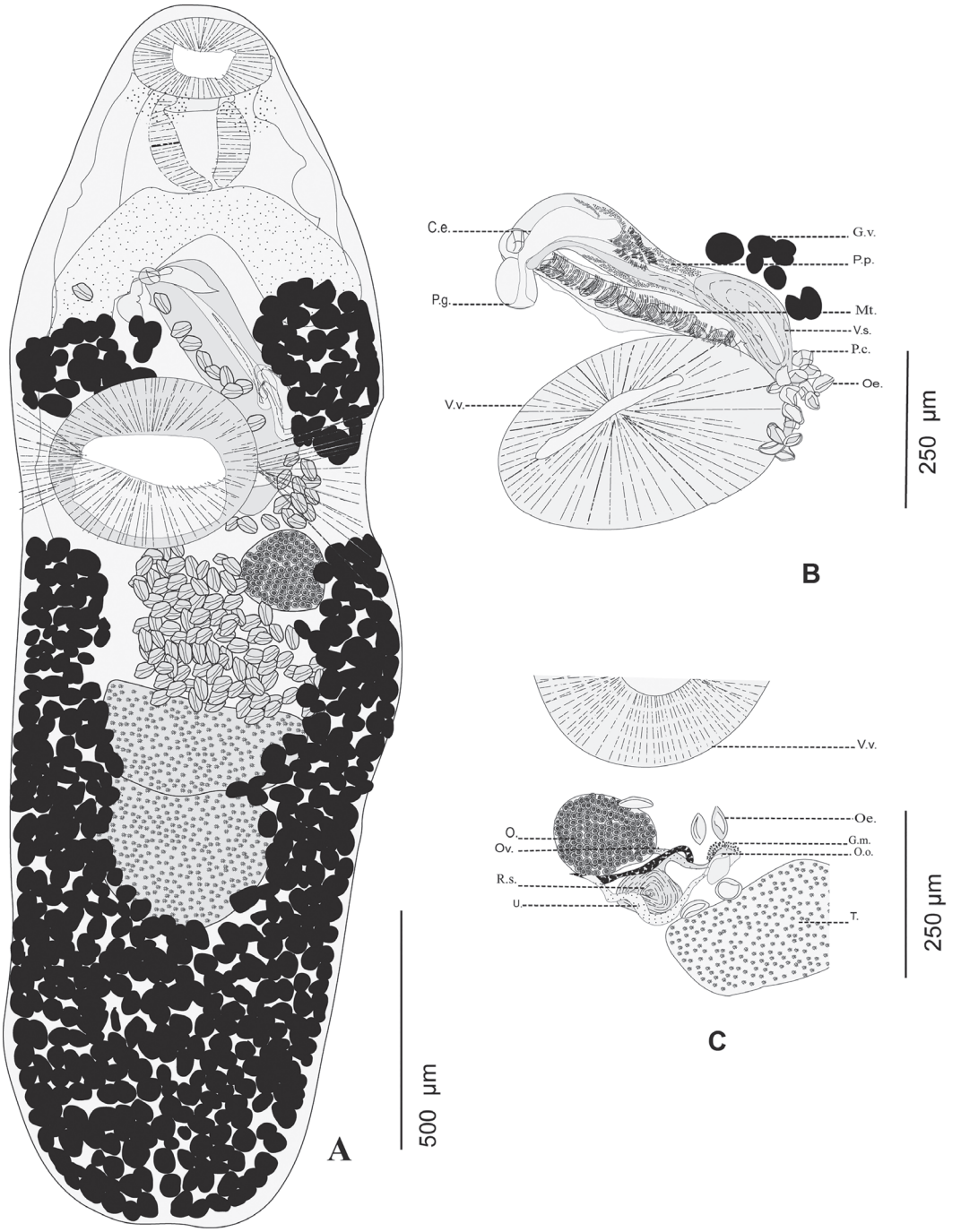


Fig. 5. *Macvicaria obovata* (Molin, 1859) ex *Sparus aurata*: A — body, ventral views; B — ventral view of the male genitalia; C — ventral view of the female genitalia.

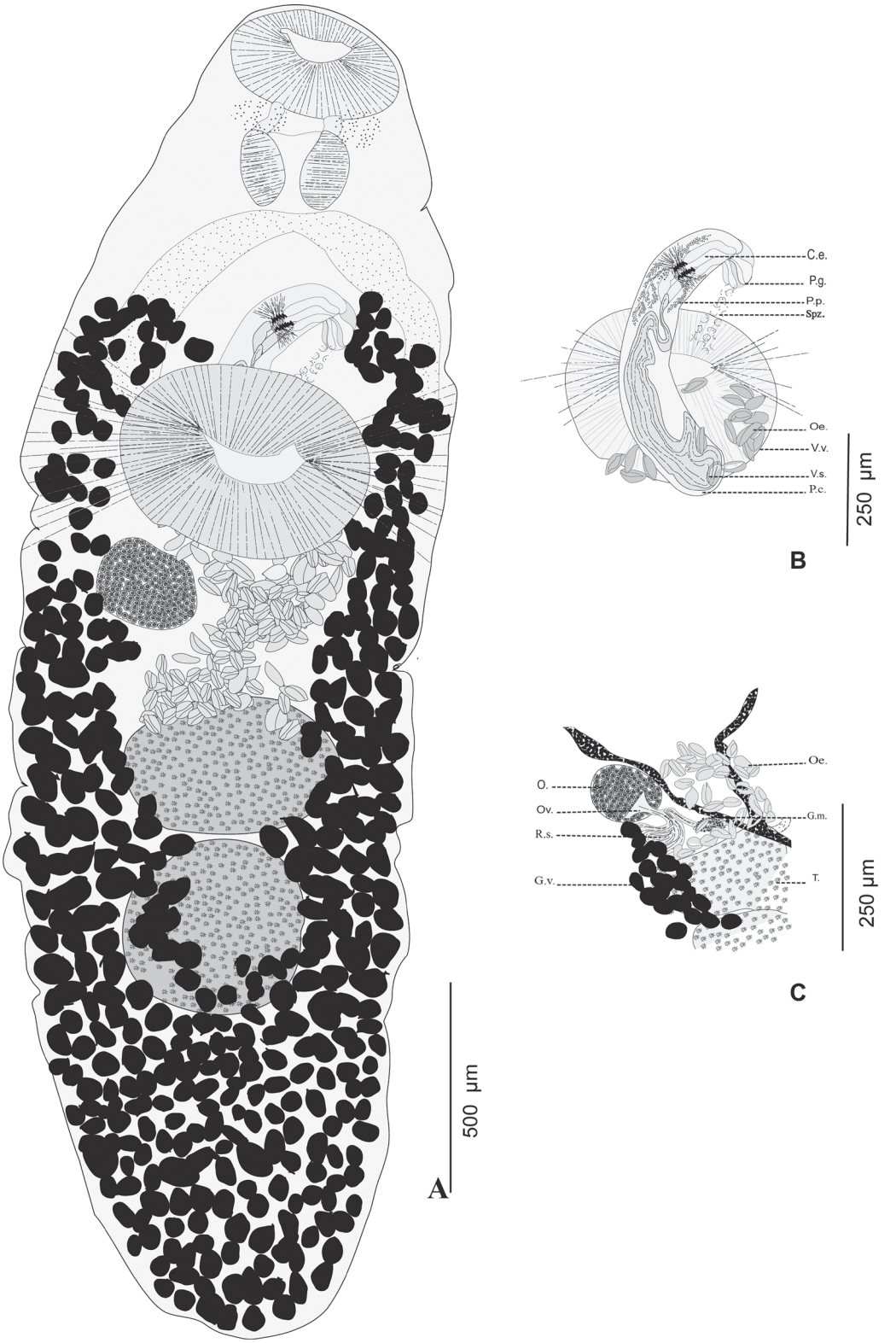


Fig. 6. *Macvicaria maillardi* Bartoli, Bray and Gibson, 1989 ex *Sparus aurata*: A — body, ventral views; B — ventral view of the male genitalia; C — ventral view of the female genitalia.

Table 4. Comparison of morphometric data of *Macvicaria maillardi* Bartoli, Bray and Gibson, 1989

Hosts	*Sparus aurata*	
Locality	Off Algeria	Off France
Source	Present study	Bartoli et al., 1989
Body length	1,295–3,719 (2,208 ± 1,942, n = 20)	2,125–4,803 (3,420 ± 1,170)
Width of the body at the ovary	103–1,182 (770 ± 326, n = 20)	808–1,811 (1,149 ± 416)
Forebody	454–1130 (693 ± 261, n = 20)	893–2,019 (1,362 ± 485)
Hindbody	606–059 (1,234 ± 522, n = 20)	893–2,805 (1,641 ± 830)
Oral sucker length	117–341 (226 ± 71, n = 20)	267–538 (382 ± 138)
Oral sucker width	201–487 (331 ± 97, n = 20)	298–666 (416 ± 176)
Ventral sucker length	290–564 (445 ± 86, n = 20)	346–640 (467 ± 150)
Ventral sucker width	322–768 (578 ± 132, n = 20)	330–629 (472 ± 160)
Prepharynx	12–75 (40 ± 24, n = 14)	43–117 (86 ± 27)
Pharynx length	117–287 (260 ± 310, n = 20)	165–357 (249 ± 100
Pharynx width	160–375 (245 ± 71, n = 20)	213–490 (339 ± 122)
Esophagus	23–111 (59 ± 29, n = 12)	43–160 (87 ± 30)
Anterior testis length	161–499 (270 ± 95, n = 20)	160–501 (299 ± 154)
Anterior testis width	152–554 (381 ± 121, n = 20)	293–640 (484 ± 190)
Posterior testis length	125–376 (244 ± 83, n = 20)	203–453 (341 ± 142)
Posterior testis width	173–634 (396 ± 141, n = 20)	240–581(433 ± 162)
Ovary length	101–257 (181 ± 51, n = 20)	149–341 (233 ± 102)
Ovary width	116–301 (214 ± 55, n = 20)	160–399(251 ± 104)
Egg length	33–76 (56 ± 16, n = 19)	61–74 (68 ± 7)
Egg width	33–85 (58 ± 16, n = 19)	26–41(34.5 ± 6)
Sucker width ratio	2 : 1.57–1.60 (1, 59)	1 : 1.06–1.48 (1.27)
Oral sucker / pharynx width ratio	1 : 1.25–1.29 (1,27)	1 : 0.45–0.80 (0.63)
Forebody / hindbody ratio	1 : 0.50–0.54 (1)	–

genital pore. Genital pore anterior to the ventral sucker and posterior to the intestinal bifurcation. Ventral to the left caecum (fig. 3, B). Ovary ovoid, entire, dextro-median, post-acetabular, pre-testicular. Oviduct short. Seminal receptacle posterior to ovary. Oötype surrounded by Mehlis' gland. Uterus coiled between the anterior testis and the ventral sucker, metraterm absent (fig. 6, C). Vitellarium follicular post-caeca bifurcation, in lateral fields, and confluent in the post-testicular region. Eggs large, operculated without filaments.

Macvicaria maamouriae Antar, Georgieva, Gargouri & Kostadinova, 2015
Host. *Sparus aurata* Linnaeus, 1758
Locality. Algerian coast in Oran.
Site in host. Intestine.
Records. Ex *Lithognathus mormyrus* off Tunisia (Antar et al., 2015) and off Algeria (Bellal et al., 2018) (fig. 4).

Description

[Based on 20 whole-mounted gravid specimens; fig. 7; measurements in table 5]

Body oval to elongated, its end rounded, with a maximum width at the level of the ventral sucker, the side edges are parallel. (fig. 7, A). Forebody and hindbody, occupying 25–39 (29.8) % and 49–59 (57.50) % of body length, respectively. Tegument

Table 5. Comparison of morphometric data of *Macvicaria maamouriae* Antar, Georgieva, Gargouri & Kostadinova, 2015

Hosts	*Sparus aurata*	*Lithognathus mormyrus*	
Locality	Algeria	Tunisia	
Source	Present study	Antar et al. (2015) N = 9 N = 6	
Body length	2,509–6,186 (4,592 ± 1,261, n = 20)	1,159–2,105	1,365–2,408
Width of the body at the ovary	745–2,169.41 (575 ± 432, n = 20)	599–943	527–932
Forebody	634–2,439 (1,344 ± 479, n = 20)	365–730	401–865
Hindbody	1,237–3,668 (2,641 ± 760, n = 20)	473–938	582–1,085
Oral sucker length	194–544 (359 ± 100, n = 20)	167–311	167–302
Oral sucker width	219 - 597 (402 ± 111, n = 20)	144–353	191–360
Ventral sucker length	425–992 (805 ± 180, n = 20)	281–412	252–428
Ventral sucker width	470–1137 (846 ± 208, n = 20)	419–592	347–644
Prepharynx	14–50 (32 ± 10, n = 18)		
Pharynx length	99–268 (190 ± 55, n = 20)	135–225	99–270
Pharynx width	116–357 (238 ± 71, n = 20)	135–248	122–261
Esophagus	91–201 (146 ± 35, n = 16)	–	–
Anterior testis length	369–1040 (745 ± 198, n = 20)	126–180	137–162
Anterior testis width	460–1162 (852 ± 264, n = 20)	266–419	218–419
Posterior testis length	335–1225 (743 ± 243, n = 20)	109–212	87–185
Posterior testis width	445–1116 (832 ± 225, n = 20)	153–387	204–282
Ovary length	140–480 (332 ± 104, n = 20)	90–167	81–209
Ovary width	135–530 (328 ± 103, n = 20)	149–257	104–329
Egg length	38–125 (72 ± 23, n = 20)	64–81 (70)	56–64 (59)
Egg width	44.79–150.23 (95 ± 31, n = 20)	36–56 (47)	33–47 (39)
Sucker ratio	1 : 2.14–1.90 (2)	–	–
Oral sucker/pharynx ratio	1 : 1.89–1.67 (2)	–	–
Forebody/Hindbody ratio	1 : 0.51–0.66 (1)	1.23–1.79	1.45

thick, not armed. Oral sucker ventro-subterminal, slightly transversely oval. Ventral sucker is transversely oval, located in the second third of the body, larger than the oral sucker, with muscle fibres radiating from the lateral edges of the sucker. Two pairs of large glandular cell groups are present in the anterior body. Prepharynx absent or very short. Pharynx strongly developed, transversely oval. Esophagus present. Intestinal bifurcation in middle of forebody; caeca thin-walled, terminating blindly near posterior body. Two testes; transversely elongated, entire margins, in tandem, contiguous, located in middle of posterior body, anterior testes slightly larger than posterior testes. Circus sac not always well visible, narrower in front, claviform, located at the level of the posterior part of the body to the anterior edge of the ventral sucker. Internal seminal vesicle tubular, wider and coiled posteriorly. Pars prostatica with very small prostatic cells. Ejaculatory duct short, very long, not armed. Genital atrium is small, genital pore sinister, ventral to the left cecum of the intestinal bifurcation (fig. 7, B). Ovary transversely oval, pre-testicular ovary with entire margins, anterior to the seminal receptacle; canalicular seminal receptacle small, located between the ovary and the anterior testis. Laurer's duct is not observed, Mehlis gland is present (fig. 7, C). Uterus short, full of eggs. Vitellarium follicular numerous, large, occupies in two broad lateral fields extending from the intestinal birufication to the posterior end of the body, confluent in the anterior body and testicular post-region. Eggs large, capped, not filamented.

These trematodes deserve more attention as they infest the same microhabitat (intestine), parasitize the same typical host (*Sparus aurata*) and share the same locality (Mediterranean). Regarding host specificity, the digeneans recovered in the present study exhibit stenoxenous (to the family level) specificity since they parasite hosts of only one family (Sparidae), except for *M. obovata* which seems to have euryxenous specificity.

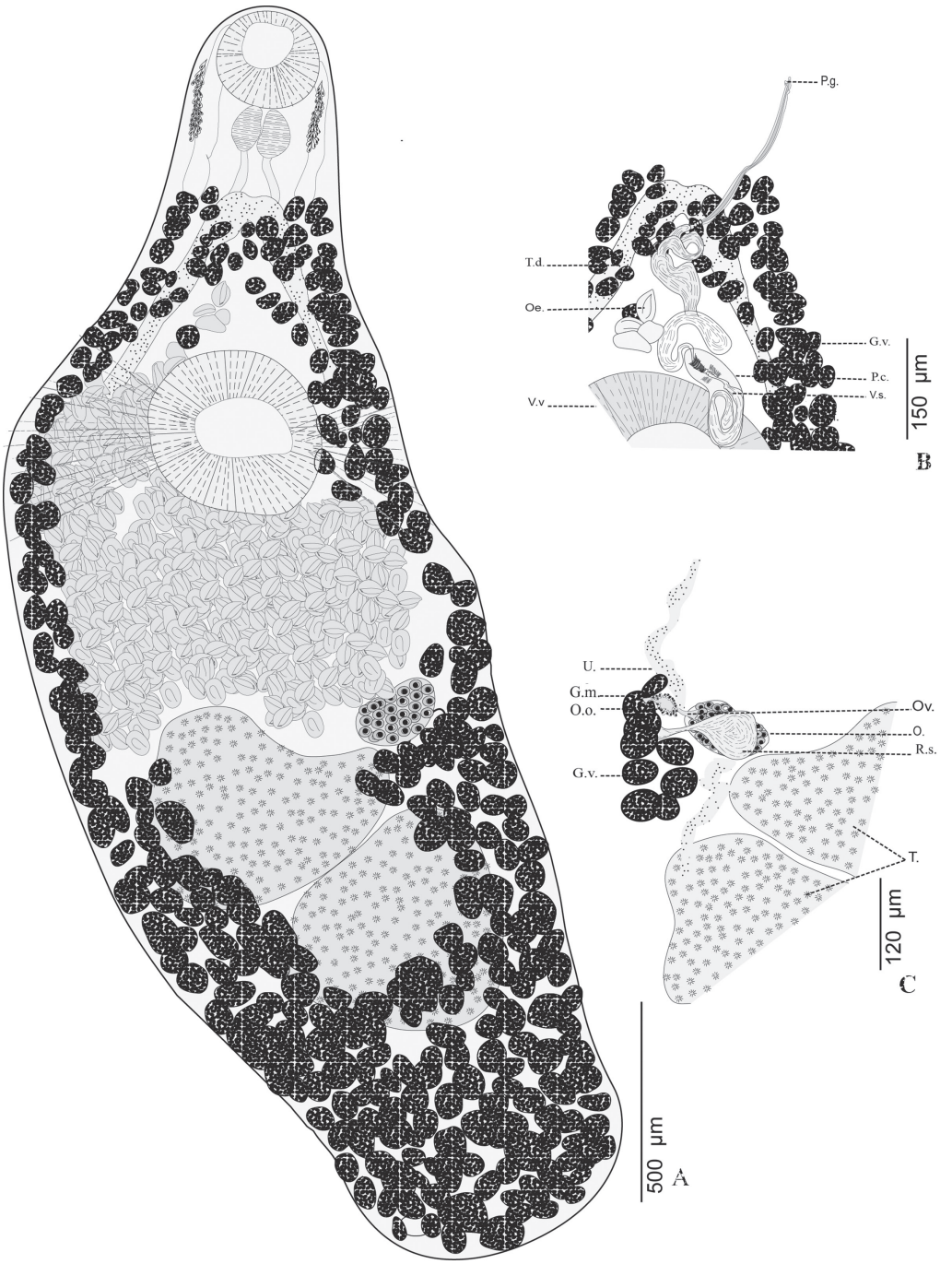


Fig. 7. *Macvicaria maamouriae* Antar, Georgieva, Gargouri et Kostadinova, 2015 ex *Sparus aurata*: A — body, ventral views of flattened specimens; B — ventral view of the male genitalia; C — ventral view of the female genitalia.

Discussion

Macvicaria obovata showed the highest prevalence (33.33 %); this value is very close to those found by Gargouri Ben Abdallah et al. (2011), Derbel et al. (2012) and Bartoli et al. (2005) who reported a higher prevalence (34.88; 36.36; 52.7 %), respectively, Antar et Gargouri (2018) reported lower prevalence (5,1) in the bay of Bizerte, Tunisia. Moreover, this species was the most abundant (table 1).

The four species redescribed in the present study belong to the family Opecoelidae Ozaki, 1925, the largest and cosmopolitan family of digeneans, with over 90 genera and nearly 900 species (Bray et al., 2016). The identification of these digeneans is based on the distribution of vitelline follicles, position and shape of the cirrus-sac, and the presence or absence of the metraterm. To date, there are 20 species of the genus *Allopodocotyle* considered valid (Worms, 2023) are known. Among these, 4 infect fishes of the family Sparidae in the Mediterranean Sea. Here, we redescribed *A. pedicellata* from its type-host *S. aurata*. This opeceolid was distinguishable by having testes in tandem, a long cirrus-sac extending to hindbody, sinister genital pore located posterior to oesophageal bifurcation and a follicular vitellarium reaching the area between the ovary and the ventral sucker. The morpho-metric data of the present specimens are similar and very close to those reported by Bartoli et al. (1989). This species is only infecting sparid fishes in the Mediterranean Sea. The species was first described from *S. aurata* and found in the same host by several authors (Stossich, 1887, 1898; Barbagallo & Drago, 1903; Janiszewska, 1953; Maillard, 1976; Papoutsoglou, 1976; Saad Fares, 1985; Bartoli et al., 1989; Derbel et al., 2012). It was also reported from *Diplodus puntazzo* Walbaum, 1792 (Papoutsoglou, 1976), *Pagrus pagrus* (Linnaeus, 1758) (Akmirza, 2000 b), *Pagrus caeruleostictus* (Valenciennes, 1830) and *Oblada melanura* (Linnaeus, 1758) (Saad Fares, 1985).

Macvicaria is a large genus of marine opecoelids that is widely distributed throughout the world. Currently, it includes 54 species considered valid (WoRMS, 2023), infecting differs families of marine teleost fishes. In the Mediterranean, eight species use as definitive hosts fishes of the family Sparidae. In this study, we retrieved three species, *M. obovata*, *M. maillardi* and *M. maamouriae*.

Macvicaria obovata is primarily characterized by uterine loops present between the ovary and anterior testis; follicular vitellarium distributed in the anterior part of the body, in non-confluent lateral fields, reaching about the level of oesophageal bifurcation, curved cirrus-sac, located almost entirely in the fore body, and the presence of metraterm. Our redescription of this species matches the description given by Bartoli et al. (1989) with some minor differences in egg size. According to the literature, two sparid-fishes (Molin, 1859, 1861; Maillard, 1976; Fischthal, 1980; Bray, 1987; Bartoli et al., 1989), and one blenniid fish (Lozano et al., 2002) seem to act as definitive hosts for this digenean species.

In *M. maillardi*, the uterus does not occupy the space between the ovary and the anterior testis while the follicular vitellarium is confluent anterior to the ventral sucker and metraterm is absent. The morphometric data shows that our specimens appear to be slightly smaller in comparison with a previous study. Nevertheless, the morphological data show no differences from the description of Bartoli et al., 1989. This parasite has been found in *S. aurata* (Stossich, 1885, 1898; Papoutsoglou, 1976; Bartoli et al., 1989) and *Lithognathus mormyrus* (Linnaeus, 1758) (Bellal et al., 2018; Gargouri Ben Abdallah et al., 2011).

Macvicaria maamouriae was originally described based on material from *S. aurata* and *L. mormyrus* off Tunisia by Antar et al., 2015. In this paper, we illustrated for the first time the male and female copulatory organs. Bellal et al., 2018 found this digenean in the intestine of *L. mormyrus*.

To summarize, we mainly used these morphological characteristics to the three species Macvicaria: the distribution of vitelline follicles in the forebody and the presence of the metraterm. Firstly, in species *M. obovata*, the vitelline follicles not fusing in the pre-acetabular region in species *M. maillardi*, the vitelline follicles confluent widely in the pre-acetabular space and in species *M. maamouriae*, the vitelline follicles contain follicles almost reaching a pharynx. Secondly, *M. obovata* is essentially characterized by uterine loops present between the ovary and the anterior testis, on the other side *M. maillardi*, the uterus does not engage between the ovary and anterior testis, and for *M. maamouriae*, the ovary and anterior testis are contiguous and not separated by uterine coils. Finally, the metraterm is present, muscular, in *M. obovata* but in the two other species *M. maillardi* and *M. maamouriae* the metraterm is absent.

A total of 29 digeneans species have been reported from the sparid fish *S. aurata* in the Mediterranean Sea, and 12 of them are recorded off the Algerian coast (Rima, 2017). In this investigation, we have collected four opecoelids species. *Allopodocotyle pedicellata* and *M. obovata* are new digeneans records to the parasitic fauna infecting teleost fish off Algeria. The remaining species have been reported in previous studies in Algeria; with these findings, the present study increased the number of digeneans infecting the gilthead sea bream off Algeria to 15 species.

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