

Research Note

 Some digenetic trematodes found in a loggerhead sea turtle (*Caretta caretta*) from Brazil

 B. CAVACO¹, L. M. MADEIRA DE CARVALHO¹, M. R. WERNECK^{2,*}

¹Interdisciplinary Animal Health Research Centre (CIISA), Faculty of Veterinary Medicine, University of Lisbon, 1300-477 Lisboa, Portugal; ²*BW Veterinary Consulting, Rua Profa. Sueli Brasil Flores n.88, Praia Seca, Araruama, RJ 28970-000(CEP), Brazil, E-mail: max@bwvet.com.br

Article info

Received December 28, 2020
Accepted February 8, 2021

Summary

This paper reports three recovered species of digeneans from an adult loggerhead sea turtle - *Caretta caretta* (Testudines, Cheloniidae) in Brazil. These trematodes include *Diaschistorchis pandus* (Pronocephalidae), *Cymatocarpus solearis* (Brachycoeliidae) and *Rhytidodes gelatinosus* (Rhytidodidae). The first two represent new geographic records. A list of helminths reported from the Neotropical region, Gulf of Mexico and USA (Florida) is presented.

Keywords: *Caretta caretta*; loggerhead turtle; trematodes; Brazil

Introduction

During the last century sea turtle populations worldwide have been declining mostly due to human activities, but also due to natural dangers, such as predation and infections caused by several pathogens, like parasites. According to the International Union for Conservation of Nature, the loggerhead turtle is considered a vulnerable species and all the populations of sea turtles have become threatened (IUCN, 2017). Therefore, it is important to study these factors in order to know its impact on these threatened species. Studies of the helminth fauna from sea turtles have already been carried out for many years and, possibly, loggerhead sea turtles (*Caretta caretta*) are the most studied species, with a large number of parasites already reported in different parts of the world (Sey, 1977, Aznar *et al.*, 1998, Werneck *et al.*, 2008; Valente *et al.*, 2009; Santoro *et al.*, 2010; Gracan *et al.*, 2012; Karaa *et al.*, 2019; Greiner, 2013). However, in Brazil a small amount of research on loggerhead sea turtles parasites has been done (Werneck & Silva, 2016; Werneck *et al.*, 2018; Werneck *et al.*, 2019). Therefore, the present article brings new knowledge on loggerheads' trematodes parasites from Brazil.

Material and Methods

In March 22, 2014 an adult female loggerhead sea turtle measuring 97.9 cm in curved carapace length was found in the Camburi beach (20° 16' 0.120" S, 40° 16' 59.880" W), municipality of Vitória in the state of Espírito Santo, Brazil. The turtle was found dead on the beach during a monitoring expedition and it was frozen. At necropsy, performed in April 29, 2014 several trematodes were found in the stomach. The contents were cleansed and concentrated with sieves (mesh sizes: 0.3 mm and 0.150 mm) and examined under a stereomicroscope. The parasites were placed in a Petri dish, preserved in 70 % alcohol, stained with carmine, and cleared with eugenol. Morphometric data was collected with the aid of a Global optics microscope using the S-EYE software program. Measurements are reported in micrometers, except when indicated, with the mean and standard deviation followed by the range in parenthesis. The analyses of the parasites were authorized by federal licenses for activities with scientific purposes (SISBIO 30600-1). The helminths were deposited in the Helminthological Collection of the Instituto Oswaldo Cruz in the state of Rio de Janeiro, Brazil (CHIOC).

* – corresponding author

The classification used in this report followed the taxonomic proposal presented by the World Register of Marine Species (WoRMS, 2020).

Ethical Approval and/or Informed Consent

For this study formal consent is not required.

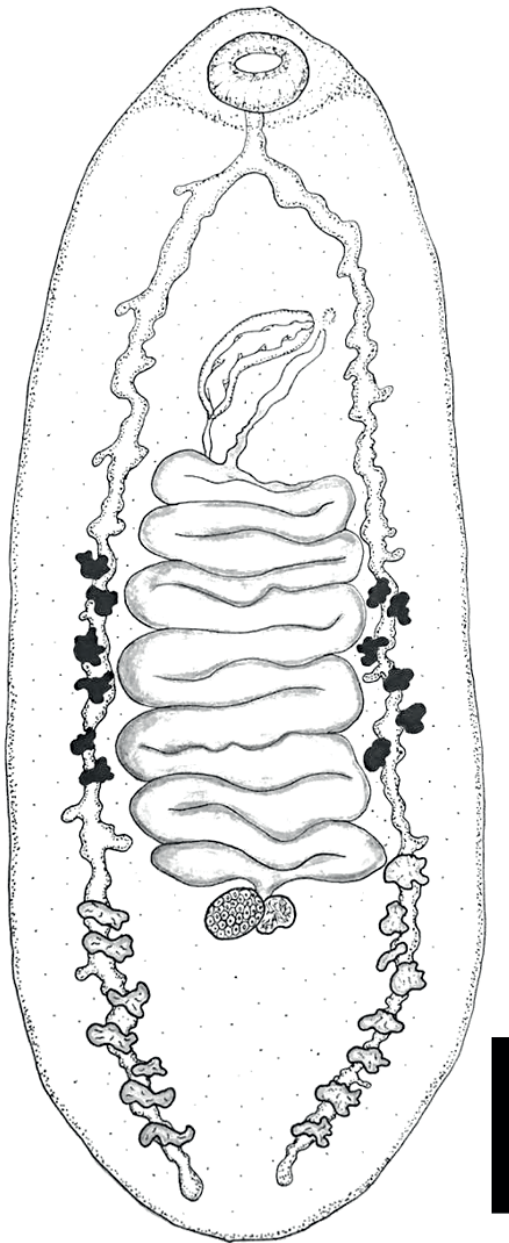


Fig. 1. *Diaschistorchis pandus* (Braun, 1901) Johnstone, 1913 (Digenea: Pronocephalidae) found in a loggerhead turtle from Brazil, ventral view (scale bar = 1.0 mm)

Results and Discussion

Three species of digeneans including 23 *Diaschistorchis pandus* (Pronocephalidae), 36 *Cymatocarpus solearis* (Brachycoeliidae) and 2 *Rhytidodes gelatinosus* (Rhytidodidae) were found in the stomach of the loggerhead turtle. The first two trematodes have new geographic records.

TREMATODA

Family: Pronocephalidae Looss, 1899

1. *Diaschistorchis pandus* (Braun, 1901) Johnstone, 1913 (Fig. 1)

Site of infection: stomach.

Voucher specimen deposited: CHIOC 38973.

Remarks: This trematode has been found in loggerheads sea turtles from Australia (Braun, 1901), USA (Pratt, 1914; Greiner, 2013), Egypt (Sey, 1977) and Tunisia (Karaa *et al.*, 2019). In Green sea turtles (*Chelonia mydas*) from Australia (Johnstone, 1913), USA (Greiner, 2013). In Halksbill sea turtles (*Eretmochelys imbricata*) from Australia (Johnstone, 1913) and India (Chattopadhyaya, 1972; Mehrotra & Gupta, 1976). In the Neotropical region (Central and South America), this trematode was already found in green sea turtles from Brazil (Werneck & Silva, 2015), in hawksbills sea turtles from Bermuda (Barker, 1922), Cuba (Vigueras, 1955), Puerto Rico (Fischthal & Acholonu, 1976; Dyer *et al.*, 1995) and Brazil (Werneck *et al.*, 2015) and loggerhead sea turtle from Brazil (present report).

Measurements: (n = 23) Body 7.75 ± 1.07 (6.46 – 9.33) mm long by 3.23 ± 0.35 (2.83 – 3.66) mm wide; oral sucker 961.9 ± 143.8 (727 – 1,201) long by 984 ± 143.9 (871 – 1,220) wide; testis number 16.6 ± 0.89 (16 – 18); ovary 318 ± 48.0 (252 – 364) long by 342.8 ± 82.4 (232 – 430) wide; cirrus sac 680.4 ± 109.6 (575 – 900) long by 225.3 ± 54.5 (156 – 302)

The morphological characteristics are compatible with the taxonomic key proposed by Blair (2005a) and Mehrotra and Gupta (1976), comparisons were made with the article by Dyer *et al.* (1995). Our specimens are comparable to those described, except the size of the body width and oral sucker, that are larger than those reported by Dyer *et al.* (1995).

Family: Brachycoeliidae Looss, 1899

2. *Cymatocarpus solearis* (Braun, 1899) Braun, 1901 (Fig. 2)

(probably Synonym: *Cymatocarpus undulatus* Looss, 1899)

Site of infection: stomach.

Voucher specimen deposited: CHIOC 38975.

Remarks: According to Blair and Limpus (1982), *C. solearis* has already been found in loggerheads sea turtles from the Mediterranean coast of Egypt and from USA (Florida) (Looss, 1899; Linton, 1910; Pratt, 1914; Luhman, 1935), in olive ridleys from Japan (Oguro, 1942) and green sea turtles from Mexico (Caballero, 1959). In Brazil it has already been reported in green sea turtles (Werneck & Silva, 2015), hawksbills sea turtles (Werneck *et al.*, 2015) and in loggerhead sea turtle (present report).

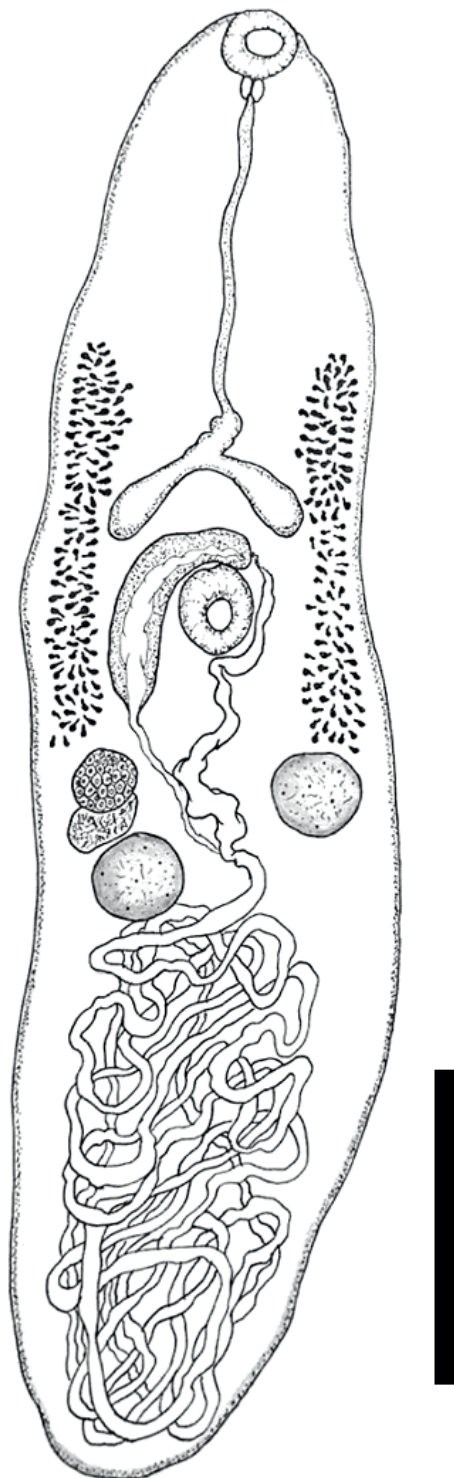


Fig. 2. *Cymatocarpus solearis* (Braun, 1899) Braun, 1901 (Digenea: Brachycoeliidae) found in a loggerhead turtle from Brazil, ventral view (scale bar=1.0 mm)

Measurements: (n = 36) Body 4.86 ± 0.83 (3.36 – 5.89) mm long by 1.30 ± 0.12 (1.12 – 1.47) mm wide; oral sucker 198.3 ± 50.1 (133 – 245) long by 231.5 ± 55.2 (161 – 291) wide; ventral sucker 262.5 ± 46.7 (171 – 301) long by 275.2 ± 55.9 (196 – 327) wide; pharynx 275.7 ± 187.6 (157 – 492) long by 72.5 ± 25.5 (46 – 107) wide; oesophagus $1,094.8 \pm 149.3$ (936 – 1296) long by 79 ± 18.7 (61 – 98) wide; anterior testis 249.2 ± 56.2 (183 – 310) long by 238.7 ± 50.0 (168 – 290); posterior testis 256 ± 60.7 (176 – 338) long by 249.6 ± 30.3 (217 – 281); ovary 204.3 ± 64.2 (142 – 321) long by 208.5 ± 49.8 (118 – 267) wide

The morphological characteristics are compatible with the taxonomic key proposed by Pojmanska (2008) and comparisons were made with the article by Blair and Limpus (1982), Caballero (1959) and Grano-Maldonado and Álvarez-Cadena (2010). The morphometric analyses of our specimens are comparable to those described by Blair and Limpus (1982) and Caballero (1959) although they were larger than largest fluke by Grano-Maldonado and Álvarez-Cadena (2010). Principal variations occurred for the size of ventral sucker, pharynx and ovary from those described by Blair and Limpus (1982).

Family: Rhytidodidae Odhner, 1926

3. *Rhytidodes gelatinosus* (Rudolphi, 1819) Looss, 1901 (Fig. 3)

Site of infection: stomach.

Voucher specimen deposited: CHIOC 38974.

Remarks: *R. gelatinosus* is a wide distributed trematode. It has been reported from loggerheads sea turtles, green sea turtles and hawksbill sea turtles, from Mediterranean sea, Morocco, USA, Puerto Rico, Cuba, Panama, India, Pakistan, New Guinea and Australia (see revision in Blair & Limpus 1982), also reported in loggerheads sea turtles from Brazil (Viana, 1924; Travassos *et al.*, 1969, present report), Egypt (Looss, 1901; Looss, 1902; Sey, 1977), USA (Greiner, 2013), . More recently in Italy (Manfredi *et al.*, 1998; Santoro *et al.*, 2010; Gracan *et al.*, 2012) and Portugal (Madeira Archipelago); Valente *et al.*, 2009), in green sea turtle from Brazil, (Werneck & Silva, 2015).

Measurements: (n=2) Body 5.31 (4.94 – 5.68) mm long by 1.27 (1.20 – 1.34) mm wide; oral sucker 355 (318 – 392) long by 469 (403 – 535) wide; pharynx 180 (160 – 200) long by 167 (147 – 187) wide; oesophagus 834 (676 – 992) long by 76 (73 – 79) wide; acetabulum 234.5 (214 – 255) long by 187 (181 – 193); ovary 175 (169 – 181) long by 225 (204 – 246) wide; cirrus sac 309 long by 183 ; anterior testis 249.2 ± 56.2 (183 – 310) long by 238.7 ± 50.0 (168 – 290); posterior testis 371 (338 – 404) long by 272.5 (244 – 301);

The morphological characteristics are compatible with the taxonomic key proposed by Blair (2005b) and the original description by Looss (1901). Our specimens are similar to those described by Blair and Limpus (1982), except that they are smaller.

Published information concerning species of parasites of the loggerhead from the Neotropical region, Gulf of Mexico and USA (Florida) is summarized in Table 1 and Table 2. The present report

Table 1. Digeneans identified in loggerhead turtle from the Neotropical region, Gulf of Mexico and Florida.

	Locality	Reference
Trematoda		
Aspidogastridae		
<i>Lophotaspis vallei</i>	Brazil, USA	Luhman, 1935; Araujo, 1941; Greiner, 2013
Brachycoelidae		
<i>Cymatocarpus solearis</i>	Brazil, USA	Linton, 1910; Pratt, 1914; Luhman, 1935; Greiner, 2013; Present report;
Calycodidae		
<i>Calycodes anthos</i>	Brazil, USA	Werneck et al., 2008; Greiner, 2013
Gorgoderidae		
<i>Plesiochorus cymbiformis</i>	Brazil, USA	Pratt, 1914; Cary, 1930; Luhman, 1935; Greiner, 2013; Werneck et al., 2018.
Pachypsolidae		
<i>Pachypsolus irroratus</i>	USA	Linton, 1910; Greiner, 2013
<i>Pachypsolus tertius</i>	Gulf of Mexico	Pratt, 1914
Plagiorchiidae		
<i>Enodiotrema carettae</i>	USA	Greiner, 2013
<i>Enodiotrema megachondrus</i>	Brazil	Werneck et al., 2019
<i>Pachypsolus tertius</i>	USA	Linton, 1910; Greiner, 2013
Pronocephalidae		
<i>Cricocephalus americanus</i>	USA	Linton, 1910
<i>Diaschistorchis ellipticus</i>	Gulf of Mexico	Pratt, 1914
<i>Diaschistorchis pandus</i>	Brazil, USA	Greiner, 2013; Present report
<i>Pleurogonius longiusculus</i>	Brazil, USA	Luhman, 1935; Ernst and Ernst, 1977
<i>Pleurogonius trigonocephalus</i>	Brazil, USA	Luhman, 1935; Ernst and Ernst, 1977; Greiner, 2013
<i>Pronocephalus trigonocephalus</i>	Brazil	Viana, 1924
<i>Pyelosomum chelonei</i>	USA	Greiner, 2013
<i>Pyelosomum renicapite</i>	Brazil, USA	Luhman, 1935; Werneck et al., 2008; Greiner, 2013
Rhytidodidae		
<i>Rhytidodes gelatinosus</i>	Brazil, USA	Viana, 1924; Travassos et al., 1969; Luhman, 1935; Greiner, 2013; Present report
<i>Rhytidodes secundus</i>	USA	Pratt, 1914; Luhman, 1935
Spirochiidae		
<i>Amphiorchis</i> sp.	USA	Dutton, 2019
<i>Carettacola bipora</i>	USA	Manter and Larson, 1950; Stacy et al., 2010; Greiner, 2013

<i>Carettacula</i> sp.	USA	Jacobson et al., 2006
<i>Hapalotrema mistroides</i>	USA	Greiner, 2013; Dutton, 2019
<i>Hapalotrema synorchis</i>	Florida	Luhman, 1935
<i>Hapalotrema pambanensis</i>	USA	Stacy et al., 2010
<i>Monticellius indicum</i>	Brazil	Werneck et al., 2017
<i>Neosporirorchis pricei</i>	USA	Manter and Larson, 1950; Stacy et al., 2010; Greiner, 2013
<i>Neosporirorchis</i> sp.	USA	Jacobson et al., 2006
Styphlotrematidae		
<i>Styphlotrema solitaria</i>	USA	Luhman, 1935; Greiner, 2013
Telorchhiidae		
<i>Orchidasma amphiorchis</i>	Argentina, Brazil, USA	Linton, 1910; Manter, 1931; Luhman, 1935; Boero and Led, 1974; Werneck et al., 2008; Greiner, 2013

Table 2. Nematodes and Cestodes identified in logghead turtle from the Neotropical region, Gulf of Mexico and Florida.

	Locality	Reference
Nematoda		
Angiostomatidae		
<i>Angiostoma carettae</i>	USA -	Burse and Manire, 2006; Manire et al., 2008
Anisakidae		
<i>Sulcascaaris sulcata</i>	Uruguay, Brazil, USA	Lent and Teixeira de Freitas, 1948; Werneck et al., 2008; Greiner, 2013
Cucullanidae		
<i>Cucullanus carettae</i>	USA	Greiner, 2013
Kathlianidae		
<i>Kathiania leptura</i>	Brazil, USA	Werneck et al., 2008; Greiner, 2013
Cestoda		
Trypanorhynch cysts	USA	Greiner, 2013

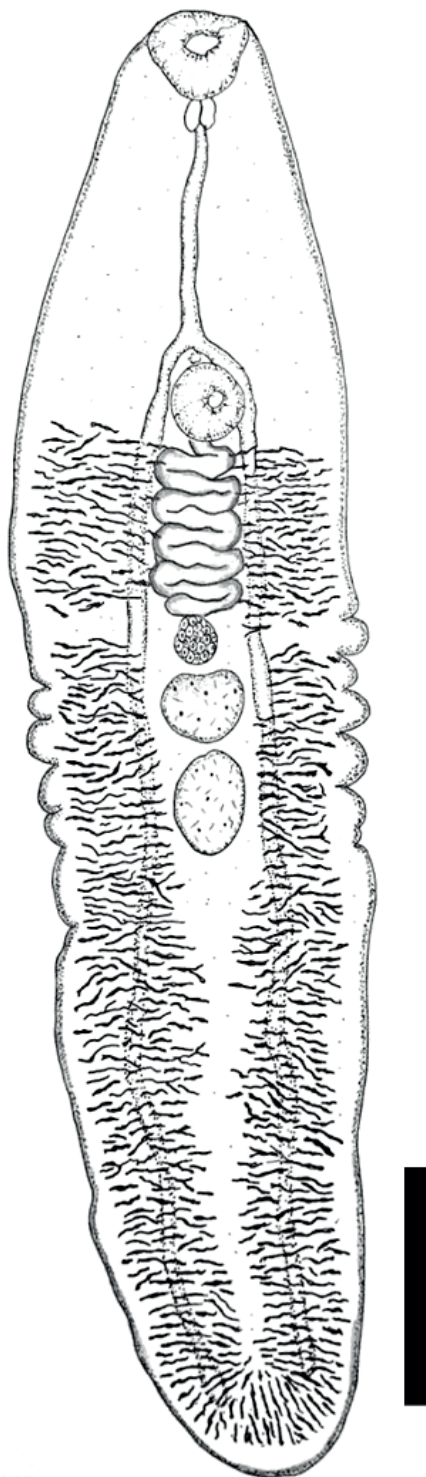


Fig. 3. *Rhytidodes gelatinosus* (Rudolphi, 1819) Looss, 1901 (Digenea: Rhytidodidae) found in a loggerhead turtle from Brazil, ventral view (scale bar=1.0 mm).

contributes to the knowledge on marine loggerheads helminth fauna and their geographical distribution.

Acknowledgments

BW is involved in veterinary medicine activities and develops specific consulting work of which one of the main aims is to disseminate scientific study results to contribute to the conservation of marine organisms.

Conflict of Interest

Authors state no conflict of interest.

References

- ARAÚJO, T.L. (1941): Nota sobre um trematoide Aspidogastridae de tartaruga marinha [Note on a sea turtle Aspidogastridae trematode]. *Bol. ind. anim.*, 4: 3 – 4 (In Portuguese)
- AZNAR, F.J., JAVIER BADILHO, F., RAGA, J.A. (1998): Gastrointestinal helminths of loggerhead turtles (*Caretta caretta*) from the Western Mediterranean: Constraints on community structure. *J. Parasitol.*, 84(3): 474 – 479
- BARKER, F.D. (1922) The parasitic worms of the animals of Bermuda. *Proc. Am. Acad. Arts. Sci.*, 57: 215-236
- BILQUEES, F.M. (1974): Two species of trematodes of *Chelonia mydas* from Karachi coast, Pakistan. *Acta Parasitol Pol.*, 22: 295-303
- BINOTI, E., GOMES, M.C., DE CALAIS JÚNIO, A., WERNECK, M.R., MARTINS, I.V.F., BOELONI, J.N. (2016): Helminth fauna of *Chelonia mydas* (Linnaeus, 1758) in the south of Espírito Santo State in Brasil. *Helminthologia*, 53(2): 195 – 199. DOI: 10.1515/helmin-2016-0012
- BLAIR, D. (2005a): Family Pronocephalidae Loss, 1899. In: JONES, A., BRAY, R.A., GIBSON, D.I. (Eds) *Keys to the Trematoda, Volume 2*. London, UK: CABI Publishing, pp. 361-380
- BLAIR, D. (2005b): Family Rhytidodidae Odner, 1926. In: JONES, A., BRAY, R.A., GIBSON, D.I. (Eds) *Keys to the Trematoda, Volume 2*. London, UK: CABI Publishing, pp. 123-125
- BLAIR, D., LIMPUS, C. J. (1982): Some Digeneas (Platyhelminthes) parasitic in the loggerhead turtle, *Caretta caretta* (L.), in Australia. *Aust. J. Zool.*, 30: 653 – 680.
- BOERO, J. J., LED, J. E. (1971): El parasitismo de la fauna autóctona [Parasitism of autochthonous fauna]. *Analecta Vet*, Volume 3, pp. 1-3 (In Spanish)
- BRAUN, M. (1901): Trematoden der Chelonier [Trematodes of the Chelonians]. *Mitt. Zool. Mus. Bert.*, 2: 5 – 58 (In German)
- BURSEY, C.R., MANIRE, C.A. (2006): *Angiostoma carettae* n. sp. (Nematoda: Angiostomatidae) from the Loggerhead Sea Turtle *Caretta caretta* (Testudines: Cheloniidae), Florida, U.S.A. *Comp. Parasitol.*, 73 (2): 253 – 256. DOI: 10.1654/4200.1
- CABALLERO, E.C. (1959): Trematodos de las tortugas de Mexico VII. Descripción de un trematodo digéneo que parasita a tortugas ma-

- rinas comestibles del puerto de Acapulco, Guerrero [Trematodes of the turtles of Mexico VII. Description of digenean trematode that parasitize comestible marine turtles from the port of Acapulco, Guerrero]. *Anales del Instituto de Biología, Univ. Nac. Aut. México*, 30:159 – 166 (In Spanish)
- CABALLERO-RODRIGUEZ, G. (1960): *Estudio de tremátodos digéneos de algunas tortugas comestibles de México [Study of dignified trematodes of some edible turtles from Mexico]*. B. S. Thesis, Mexico City: Facultad de Ciencias, Universidad Nacional Autónoma de México. (In Spanish)
- CARY, L.R. (1930): Report on Investigations at Tortugas. Studies on Miracidia. *Yearb. Carnegie Inst. Wash.*, 29: 325-329
- DUTTON, H.R., WARREN, M.B., BULLARD, S.A. (2019): New Genus and Species of Turtle Blood Fluke (Platyhelminthes: Digenea: Schistosomatoidea) Infecting Six-Tubercled Amazon River Turtles, *Podocnemis sextuberculata* (Pleurodira: Podocnemididae) from the Amazon River Basin (Peru). *J. Parasitol.*, 105(5): 671-685. DOI: 10.1645/19-68
- DYER, W.G., WILLIAMS, E.H.J., BUNKLEY-WILLIAMS, L., MOORE, D. (1995): Some digeneans (Trematoda) of the hawkbill turtle, *Eretmochelys imbricata imbricata* (Testudines: Cheloniidae) from Puerto Rico. *Proc. Helminthol. Soc. Wash.*, 62: 13 – 17
- EUZET, L., COMBES, C. (1962): Deux trematodes digenes de *Thalassochelys caretta* (L.) [Two digenous trematodes of *Thalassochelys caretta* (L.)]. *Bull. Soc. Fr.*, 87: 15-22 (In French)
- EUZET, L., COMBES, C., TRIQUELL, A. (1972): Sur deux trematodes de *Caretta caretta* (L.) des côtes Méditerranéennes françaises [On two *Caretta caretta* (L.) trematodes from the French Mediterranean coast]. *Vie Milieu*, 23: 157-167 (In French)
- ERNST, E.M., ERNST, C.H. (1977): Synopsis of helminths endoparasitic in native turtles of the United States. *Bull. Md. Herpetol. Soc.*, 13(1):1-75.
- FERNANDES, M.M., KOHN, A. (2014): *South American trematodes parasites of amphibians and reptiles*. Oficina de Livros, Rio de Janeiro, Brazil, 228
- FISCHTHAL, J.H., ACHOLONU, A.D. (1976): Some digenetic trematodes from the Atlantic hawkbill turtle, *Eretmochelys imbricate imbricata* (L) from Puerto Rico. *Proc. Helminthol. Soc. Wash.*, 43(2): 174 – 185
- GRACAN, R., BURSIC, M., MLADINEO, I., KUCINIC, M, LAZAR, B., LACKOVIC, G. (2012): Gastrointestinal helminth community of loggerhead sea turtle *Caretta caretta* in the Adriatic Sea. *Dis. Aquat. Org.*, 99: 227 – 236. DOI: 10.3354/dao02490
- GRANO-MALDONADO, M., ÁLVAREZ-CADENA, J. (2010): In Vitro Cultivation of *Cymatocarpus solearis* (Brachycoeliidae) Metacercariae to Obtain the Adult Stage without the Marine Turtle Definitive Host. *Korean J Parasitol*, 48(1): 49-55. DOI: 10.3347/kjp.2010.48.1.49
- GREINER, E.C. (2013): Parasites of marine turtles. In: WYNEKEN, J, LOHMANN, K.J., LUTZ, J.A. (Eds) *The Biology of Sea Turtles*. Volume 3. Florida: CRC Press, Boca Raton, pp. 427 – 446
- IUCN (2017): Loggerhead Turtle (2017): *Caretta caretta*. In: *The IUCN Red List of Threatened Species 2017*. Retrieved September 23, 2020, from: www.iucnredlist.org.
- KARAA, S., JRIBI, I., MAROUANI, S., JRJER, J., BRADAI, M.N. (2019): Preliminary Study on Parasites In Loggerhead Turtles (*Caretta caretta*) From The Southern Tunisian Waters. *Am J Biomed Sci Res*, DOI: 10.34297/AJBSR.2019.05.000949
- LINTON, E. (1910): *Helminth fauna of the Dry Tortugas: Trematodes II*. Volume 4. Carnegie Institution of Washington Tortugas Laboratory.
- LOOSS, A. (1899): Weitere Beiträge zur Kenntniss der Trematoden - Fauna Aegyptens, zugleich Versuch einer natürlichen Gliederung des Genus *Distomum* Retzius [Further contributions to the knowledge of the trematode fauna of Egypt, at the same time an attempt at a natural classification of the genus *Distomum* Retzius]. *Zoologische Jahrbücher.*, 12: 521-784 (In German)
- LOOSS, A. (1901): Notizen zur helminthologie Egyptens. IV. Ueber trematoden aus seeschildkröten der Egyptischen küsten [Notes on the helminthology of Egypt. IV. About trematodes from sea turtles of the Egyptian coasts]. *Centralblatt Bakteriol Parasit. Abt. 1 Orig.*, 30: 555 – 569 (In German)
- LOOSS, A. (1902): Ueber neue und bekannte trematoden aus seeschildkröten. Nebst erörterungen zur systematik und nomenclatur. [About new and well-known sea turtle trematodes. In addition to discussions on systematics and nomenclature.] *Zool. Jahr. Syst.*, 16: 411 – 894 (In German)
- LUHMAN, M. (1935): Two new trematodes from the loggerhead turtle (*Caretta caretta*). *J. Parasitol.*, 21: 274-276
- MANFREDI, M. T., PICCOLO, G., MEOTTI, C. (1998): Parasites of Italian sea turtles. II. Loggerhead turtles (*Caretta caretta* [Linnaeus, 1758]). *Parasitologia*, 40: 505 – 508
- MANIRE, C.A., KINSEL, M.J., ANDERSON, E.T., CLAUSS, T.M., BYRD, L. (2008): Lungworm infection in three loggerhead sea turtles, *Caretta caretta*. *J. Zoo Wildl. Med.*, 39: 92 – 98. DOI: 10.1638/2007-0092.1
- MANTER, H. W. (1931): Further studies on trematodes of Tortugas fishes. *Yearb. Carnegie Inst. Wash.*, 30: 386-388
- MANTER, HW. (1954). Trematoda of the Gulf of Mexico. In: GALT-SOFF, P.S. (Ed) *Gulf of Mexico its origin, waters, and marine life*. Washigton: Fishery bulletin of the fish and wildlife service, pp. 335-348
- MANTER, H.W., LARSON, M.I. (1950): Two New Blood Flukes from a Marine Turtle, *Caretta caretta*. *J. Parasitol.*, 36 (6): 595-599
- MARCHIORI, E., NEGRISOLO, E., CASSINI, R., GAROFALO, L., POPPI, L., TESSARIN, C., MARCER, F. 2017, Cardiovascular flukes (Trematoda: Spirorchidae) in *Caretta caretta* Linnaeus, 1758 from the Mediterranean Sea. *Parasit Vectors*, 10: 467. DOI: 10.1186/s13071-017-2396-x
- MARCHIORI, E., DOTTO, G., TESSARIN, C., SANTORO, M., AFFUSO, A., TARRICONE, L., DI RENZO, L., FREGGI, D., SPOTO, V., MARCER, F., 2020 A pilot study on molecular diagnosis of *Hapalotrema mistroides* (Digenea: Spirorchidae) infection in blood samples of live loggerhead turtles *Caretta caretta*. *BMC Vet Res*, 16: 16. DOI: 10.1186/s12917-020-2232-y

- MEHROTRA, V., GUPTA, N.K. (1976). On two species of the genus *Dischistorchis* Johnston, 1913 (Trematoda: Pronocephalidae) from marine turtles in India. *Riv. Parassit.*, 38(2-3): 279-286.
- OGURO, Y. (1942): Short report of trematodes of chelonians. *Zool. Mag.*, 54: 164
- PÉREZ-PONCE DE LEÓN, G. P., GARCÍA-PRÍETO, L., LEÓN-RÉGAGNON, V. (1996): Gastrointestinal digenetic trematodes of Olive Ridley's turtle (*Lepidochelys olivacea*) from Oaxaca Mexico. Taxonomy and Infracommunity structure. *J. Helminthol. Soc. Wash.*, 63: 76 – 82
- PERÉZ-VIGUERA, I. (1955): Contribucion al conocimiento de la fauna helmintologica cubana [Contribution to the knowledge of the Cuban helminthological fauna]. *Mem. Soc. Cubana Hist. Nat. 'Felipe Poey'*, 22: 21-71 (In Spanish)
- POJMANSKA, T. (2008): Family Brachycoeliidae Loss, 1899. In: BRAY, R.A., GIBSON, D.I., JONES, A. (Eds) *Keys to the Trematoda*. Volume 3. London, UK: CABI Publishing, pp. 219-224
- PRATT, H. S. (1914): Trematodes of the loggerhead turtle (*Caretta caretta*) of the Gulf of Mexico. *Arch. Archives de Parasitologie Paris.*, 16: 411 – 427
- SANTORO, M., BADILLO, F.J., MATTIUCCI, S., NSACENTI, G., BENTIVEGNA, F., INSACCO, G., TRAVAGLINI, A., PAOLETTI, M., KINSELLA, J.M., TOMÁS, A., RAGA, J., AZNAR, F.J. (2010): Helminth communities of loggerhead turtles (*Caretta caretta*) from central and western Mediterranean Sea: The importance of host's ontogeny. *Parasitol Int*, 59: 367 – 375. DOI: 10.1016/j.parint.2010.04.009
- SANTORO, M., GREINER, E.C., MORALES, J.A., RODRÍGUEZ-ORTÍZ, B. (2006): Digenetic trematode community in nesting green sea turtles (*Chelonia mydas*) from Tortuguero National Park, Costa Rica. *J. Parasitol.*, 92: 1202 – 1206. DOI: 10.1645/GE-866R.1
- SANTORO, M., NOCERA, F.DI., IACCARINO, D., LAWTON, S.P., CERRONE, A., DEGLI UBERTI, B., D'AMORE, M., AFFUSO, A., HOCHSCHEID, S., MAFFUCCI, F., GALIERO, G. (2017): Pathology and molecular analysis of *Haplotrema mistroides* (Digenea: Spirorchiidae) infecting a Mediterranean loggerhead turtle *Caretta caretta*. *Dis. Aquat. Org.*, 124: 101-108. DOI: 10.3354/dao03117
- SEY, O. (1977): Examination of helminth parasites of marine turtles caught along the Egyptian coast. *Acta Zool. Acad. Sci. Hung.*, 23: 387-394
- SINHA, S.S., CHATTOPADHYAYA, D. R. (1969): Studies on the Family Rhytidodidae Odhner. 1926, with a description of a new species *Rhytidodes indicus*, from the intestine of *Eretmochelys squamosa*, from Rameswaran, India. *Riv. Parassitol.*, 30: 95-100
- JACOBSON, E.R., HOMER, B.L., STACY, B.A., SZABO, N.J., CHRISMAN, C.L., ORIGGI, F., COBERLEY, S., FOLEY, A.M., LANDSBERG, J.H., FLEWELLING, L., EWING, R.Y., MORETTI, R., SCHAF, S., ROSE, C., MADER, D.R., HARMAN, G.R., MANIRE, C.A., METTEE, N.S., MIZISIN, A.P., SHELTON, G.D. (2006): Neurological disease in wild loggerhead sea turtles *Caretta caretta*. *Dis. Aquat. Org.*, 70: 139-154. DOI: 10.3354/dao070139
- STACY, B.A., FOLEY, A.M., GREINER, E., HERBST, L.H., BOLTON, A., KLEIN, P., MANIRE, C.A., JACOBSON, E.R. (2010): Spirorchiidiasis in stranded loggerhead *Caretta caretta* and green turtles *Chelonia mydas* in Florida (USA): host pathology and significance. *Dis. Aquat. Org.*, 89: 237 – 259. DOI: 10.3354/dao02195
- TRAVASSOS, L., FREITAS, T., KOHN, A. (1969): Trematódeos do Brasil [Trematodes from Brazil]. *Mem. Inst. Oswaldo Cruz*, 67: 1 – 886 (In Portuguese)
- VALENTE, A.L., DELGADO, C., MOREIRA, C., FERREIRA, S., DELLINGER, T., PINHEIRO DE CARVALHO, M.A.A., COSTA, G. (2009): Helminth component community of the loggerhead sea turtle, *Caretta caretta*, from Madeira Archipelago, Portugal. *J Parasitol*, 95: 249 – 252. DOI: 10.1645/GE-1519.1
- VIANA, L. (1924): Tentativa de catalogação das espécies brasileiras de trematódeos [Attempt to catalog Brazilian trematode species]. *Mem. Inst. Oswaldo Cruz*, 17: 95 – 227 (In Portuguese)
- VIGUEIRAS, P. (1955): Contribución al conocimiento de la fauna helmintológica cubana [Contribution to the knowledge of the Cuban helminthological fauna]. *Mem. Soc. Cub. Hist. Nat.*, 22: 21 – 71 (In Spanish)
- WERNECK, M.R., THOMAZINI, C.M., MORI, E.S., GONÇALVES, V.T., GALLO, B.M.G., SILVA, R.J. (2008): Gastrointestinal helminth parasites of Loggerhead turtle *Caretta caretta* Linnaeus 1758 (Testudines, Cheloniidae) in Brazil. *Panam J Aquat Sci*, 3(3): 351-354.
- WERNECK, M.R., SILVA, R.J. (2015): Some helminth parasites of juvenile green turtles *Chelonia mydas* (Testudines, Cheloniidae) in Brazil. *J Parasitol*, 101(6): 713 – 716. DOI: 10.1645/15-780
- WERNECK, M.R., LIMA, E.H.S.M., PIRES, T., SILVA, R.J. (2015): Helminth parasites of the Juvenile Hawksbill Turtle *Eretmochelys imbricata* (Testudines, Cheloniidae) in Brazil. *J Parasitol*, 101(4): 130 – 134. DOI: 10.1645/13-479.1
- WERNECK, M. R., SILVA, R.J. (2016): Checklist of sea turtles endohelminths in Neotropical region. *Helminthologia*, 53: 211 – 223. DOI: 10.1515/helmin-2016-0045
- WERNECK, M. R., NUNES, C., JERDY, H., CARVALHO, C.Q. (2017): Loggerhead turtle, *Caretta caretta* (Linnaeus, 1758) (Testudines, Cheloniidae), as a new host of *Monticellius indicum* Mehra, 1939 (Digenea: Spirorchiidae) and associated lesion to spirorchiid eggs. *Helminthologia*, 54(4): 363 – 368. DOI: 10.1515/helm-2017-0047
- WERNECK, M.R., MASTRANGELLI, A., VELLOSO, R., JERDY, H., CARVALHO, E.C.Q. (2018): Chronic Cystitis Associated with *Plesiochorus cymbiformis* (Rudolphi, 1819) Looss, 1901 (Digenea: Gorgoderidae) in a Loggerhead Turtle *Caretta caretta* (Linnaeus 1758) (Testudines, Cheloniidae) from Brazil: A Case Report. *J Parasitol*, 104(3), 334 – 336. DOI: 10.1645/17-116
- WERNECK, M.R., BALDASSIN, P., MASTRANGELLI, A., JERDY, H. (2019): The First Occurrence of *Enodiotrema megachondrus* in a Loggerhead Turtle Found on the Coast of Brazil. *EC Veterinary Science*, 4.3: 148-152
- WoRMS - World Register of Marine Species (2020). Retrieved November 18, 2020 from: <http://www.marinespecies.org/index.php>