

Redescription of *Monocotyle myliobatis* (Monogenea, Monocotylidae) from the type host *Myliobatis aquila* (Elasmobranchii, Myliobatidae) off the Algerian coast

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Abstract

Monocotyle was proposed by Taschenberg (1878) to accommodate *M. myliobatis* Taschenberg, 1878 from the gills of *Myliobatis aquila* (Linnaeus) caught at the Aquarium of the Zoological Station of Naples (Italy). There have been three descriptions of this species: the original one by Taschenberg (1878) and two which are incomplete by Perugia and Parona (1890) and Palombi (1942). Illustrations by these authors are poor and sometimes conflicting. We have rediscovered *M. myliobatis* on the gills of the type host *Myliobatis aquila* caught near Algiers, Tamentfoust (36°47'N, 3°12'E) (Algeria). We provide new illustrations of this monogenean, based on new specimens. We also redescribe the anatomy, with special attention to the male and female reproductive systems, and we provide additional data regarding the morphology, the number and arrangement of the septal sclerites of the haptor and the haptor marginal papillae. We indicate the similarity between *Monocotyle myliobatis* and *Monocotyle* sp. Euzet et Maillard, 1967 collected from *Pteromyxus bovinus*, Geoffroy Saint Hillaire (Elasmobranchii, Myliobatidae) by J. Cadenat off Dakar (Senegal).

Keywords

Monogenea, Monocotylidae, *Monocotyle myliobatis*, *Myliobatis aquila*, Mediterranean, Algerian coast

Introduction

Taschenberg (1878) erected *Monocotyle* to accommodate *Monocotyle myliobatis* Taschenberg, 1878 a gill parasite of *Myliobatis aquila* (Linnaeus) collected from the Aquarium of the Zoological Station of Naples, Italy. His description is very brief and does not include detailed anatomy. Perugia and Parona (1890) found specimens of this species on *M. aquila* collected in Trieste but according to Chisholm (1998) they confused the sclerotised male copulatory organ with the filament of a uterine egg and thus gave an erroneous description of the male and female genitalia. Later the species was reported off Trieste by Sonsino (1890) and by Stossich (1898).

Monocotyle myliobatis was described and illustrated by Palombi (1942) from material collected by Monticelli at Naples from the gills of *M. aquila*. This description, summarized extensively, by Palombi (1949), is different from this of Perugia and Parona (1890) but also incomplete and erroneous.

Euzet and Maillard (1967) found two specimens of *Monocotyle* spp. on the gills of *Pteromyxus bovinus* (E. Geoffroy Saint-Hillaire) from Dakar (Senegal). They specify the coiled morphology of the male copulatory organ and hypothesize that this parasite may be *Monocotyle myliobatis*.

Eighteen species of *Monocotyle* have been described (see Portes Santos *et al.* 2006) but the description of *M. myliobatis*, type species of the genus, remains incomplete. We have collected eighteen specimens of a *Monocotyle*, from the gills of *Myliobatis aquila* captured from Algerian coasts, near Algiers. We considered these specimens to be Taschenberg's *Monocotyle myliobatis* and give herein a detailed redescription of this species and a revised diagnosis for the genus.

Materials and methods

Two individuals of *Myliobatis aquila* were collected in 24 and 27 July 2008 near Algiers using gillnet and were dissected

shortly after capture. The gill arches, excised by a dorsal and ventral incision, were placed in Petri dishes empty with filtered sea water and inspected individually under a dissecting microscope. Monogeneans were removed alive from the edge of primary and second gill lamellae, using fine dissection needle. Specimens were studied either directly under a microscope or fixed, slightly flattened between slide and coverslip. Two fixatives were used: 70% ethanol and Bouin-Hollande (Martoja and Martoja-Pierson 1967). Specimens were stained with Grenacher's carmine or Semichon's carmine. After dehydration they were cleared in clove oil and mounted in Canada balsam.

Drawings were made with the help of a Leitz microscope drawing tube. All measurements are given in micrometres as the mean followed, in parentheses, by the range and the number measurements (n). Haptor terminology follows that presented and illustrated by Neifar *et al.* (1998). We use the term uncinulus for the small larval hooklets and anchor for posterior hooks. Terminology and measurements of the anchor are presented in Figure 2C (l = total length, b = blade, g = guard, h = handle, p = point). All septa and marginal papillae are armed with sclerites of different morphology (Fig. 2A). Sclerites are classified as unicuspid (Type A), bicuspid (Type B and Type D) and tricuspid (Type E) as proposed by Measures *et al.* (1990).

Results

Class: Monogenea (Carus, 1863) Bychowsky, 1937
 Subclass: Monopisthocotylea Odhner, 1912
 Family: Monocotylidae Taschenberg, 1878
 Subfamily: Monocotylinae Taschenberg, 1878

Monocotyle myliobatis Taschenberg, 1878 (Figs 1–3)

Amended description (based on 18 flattened adults specimens). Total body, including haptor, 6760 (5150–8150) (n = 16) long and 1970 (1800–2250) (n = 16) wide at level of testis. Haptor subcircular 1510 (1450–1660) (n = 18) long and 1426 (1330–1760) (n = 18) wide, with the posterior half little more developed as anterior. Haptor divided into one central and eight peripheral loculi, separated by one inner ring septum, eight radial muscular septa and one outer ring septum (Fig. 1). One sclerotised anchor in ventral expansion at posterior extremity of each posterolateral septum. A bundle of muscular fibers in each postero-lateral septa, from the body to the proximal extremity of the anchor. The distal extremities of the expansion protrude beyond the marginal membrane. Anchor well developed 550 (350–580) (n = 21) long with long handle 351 (300–486) (n = 21), reduced guard 97 (100–156) (n = 21), short blade 77 (50–92) (n = 21), and acute point 69 (50–80) (n = 21) (Fig. 2B). Fourteen uncinuli (7 pairs), 12 (11–13) (n = 28) long, distributed symmetrically in marginal membrane.

Marginal papillae, radial, inner and outer rim septa of the haptor armed with sclerites. Eighty marginal papillae each with 3 Type B sclerites. Terminal sclerite not distinct from other papillary sclerite. On each side, posterior loculus with 12 papillae, posterolateral loculus with 10 papillae, anterolateral and anterior loculus with 9 papillae. Six (or rarely five) papillae between each uncinulus except in the posterior region between uncinuli II and III, with two papillae on each side of anchor. Outer ring septum (ORS) with 235–240 Type A sclerites, one at base of each papillae and two in space between two papillae. Posteromedian septum (PMS) with 29–31 Type

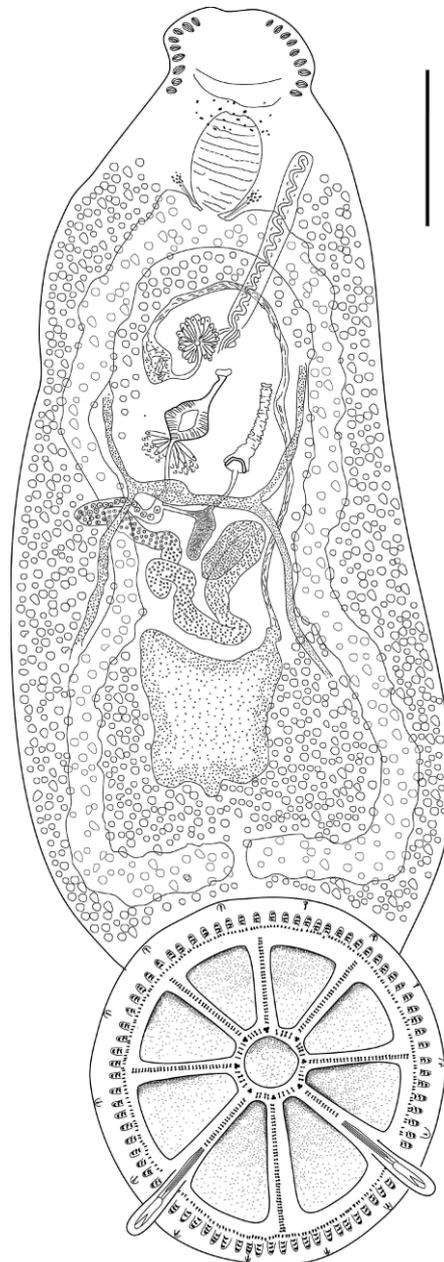


Fig. 1. *Monocotyle myliobatis* Taschenberg, 1878. Whole animal, composite drawing, ventral view. Scale bar = 500 μ m

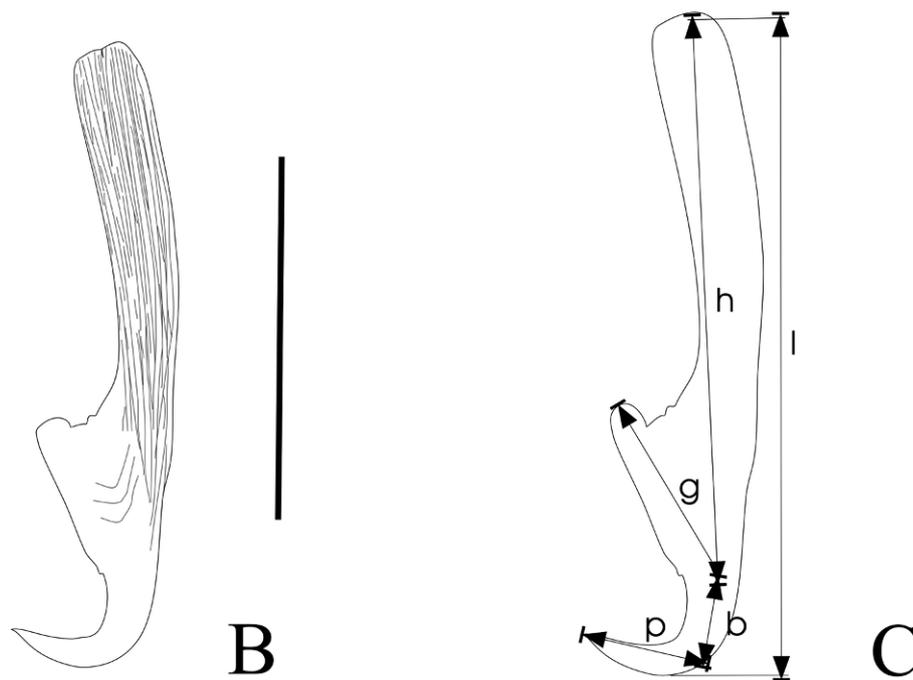
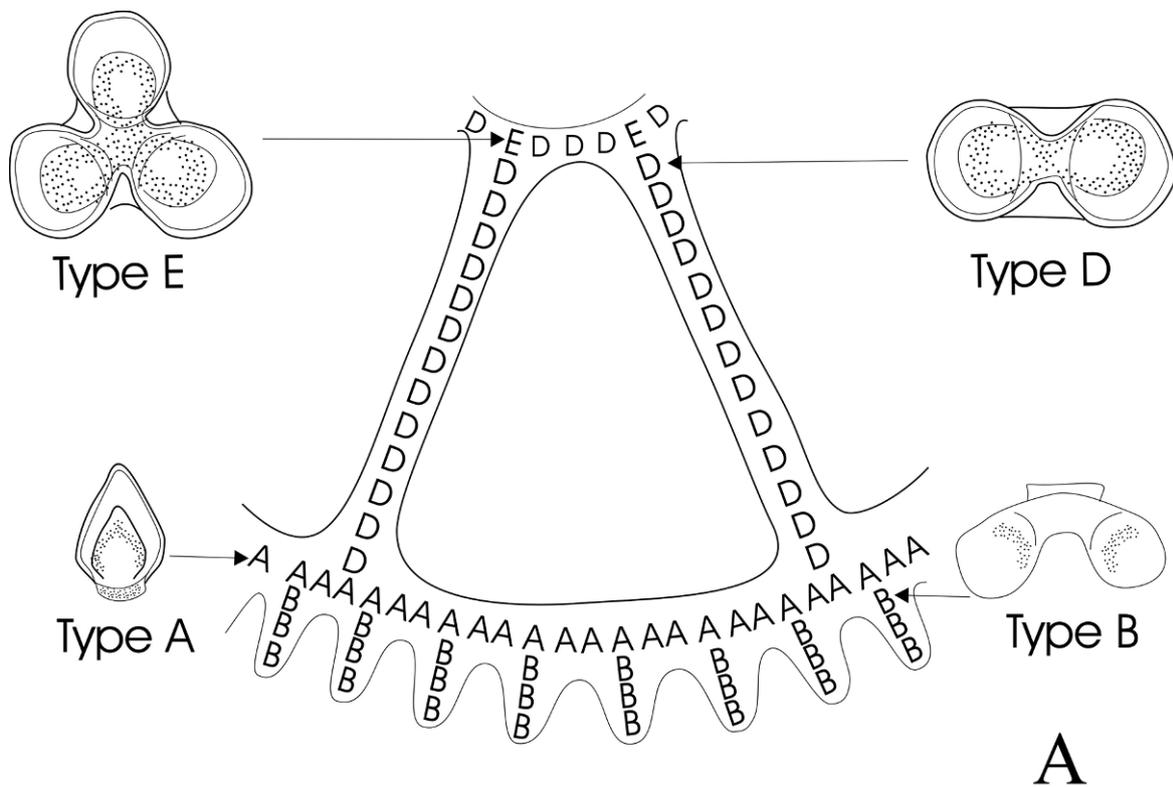


Fig. 2. *Monocotyle myliobatis* Taschenberg, 1878. **A** – arrangement of septal and papillar haptor sclerites (Type A – unicuspid outer rim sclerites, Type B – bicuspid marginal papillae sclerites, Type D – bicuspid radial septal sclerites, Type E – tricuspid sclerites at the junction of radial septa and inner ring septum). **B** – anchor morphology, scale bar = 250 μ m. **C** – anchor method of measurements (b – blade, g – guard, h – handle, l – total length, p – point)

C sclerites, posterolateral septa (PLS) with 22–23 Type C, lateral septa (LS) with 25–26 Type C, anterolateral septa (ALS) with 25–26 Type C, anteromedian septum (AMS) with 21–22 Type C. Inner ring septum (IRS) with 32–40 Type C sclerites, each 4 or 5 separated by one tripartite Type E sclerite at the extremity of each radial septum. Schematic arrangement of sclerites shown in Figure 2A.

Mouth ventral, subterminal, surrounded by muscular pseudosucker. Eight or nine anterolateral gland duct opening on each side of oral pseudosucker. Pharynx 514 (410–650) ($n = 17$) long and 386 (310–480) ($n = 17$) wide. Unbranched intestinal caeca, irregularly constricted, running parallel with body margin, turning medially posterior to testis and terminating blindly in centre of prehypostomal region. Ocellar pigment granules, dispersed dorsally anterior to pharynx. No posterior dorsal body protuberances.

One posteromedian testis with vas deferens arising from left anterior side. Vas deferens running anteriorly, dorsal to left transverse vitelline duct, not encircling left caecum. Vas deferens curving to right side of the body, enlarging to form seminal vesicle and entering at centre of spherical, glandular, ejaculatory bulb 192 (190–290) ($n = 14$) diameter. Male copulatory organ (MCO) on the left anterior side of the body, 607 (560–800) ($n = 16$) long, enclosed by muscular sheath. Ejaculatory duct entering at the base of sheath, coiled with twelve ascendant, one anterior albow and twelve sclerotised descendant loops (Fig. 3A). Distal end of MCO armed with sclerotised accessory piece 122 (112–131) long near the genital pore (Fig. 3B and 3C).

Ovary sinuous elongate, anterior to testis, beginning by massive left part, ascending on right side and looping right intestinal caecum dorso-ventrally. Ventral vaginal pore between left and median side of the body. Vaginal walls not sclerotised but proximal region of vagina with one hemispherical sclerotised sclerite 142 (110–165) ($n = 16$) at greatest diameter (Fig. 3D). Vaginal duct narrows before entering seminal receptacle to ovary. Vitelline follicles lateral, extending dorso-ventrally from level of pharynx to posterior margin of body proper as illustrated in Figure 1. On each side of the body, anterior and posterior lateral vitelline ducts unite to form transverse vitelline duct at level of anterior portion of ovary. Seminal vesicle between left transverse vitelline duct and ovary. Mehlis gland and ducts present at the base of ootype. Ootype medial and ventral with thick glandular walls. Ootype eggs tetrahedral (teratologic) 96 (70–120) ($n = 5$) side with posterior polar appendage 60 (45–80) ($n = 5$) long.

Type-host: *Myliobatis aquila* (Linnaeus, 1758) (Myliobatidae).

Type-locality: Naples, Italy.

Other locality: Trieste, Italy.

New locality: Tamentfoust (36°47'N, 3°12'E), Algeria.

Microhabitat: Edge of primary and secondary gill lamellae.

Material examined: 2 hosts infected respectively with 8 and 10 parasites.

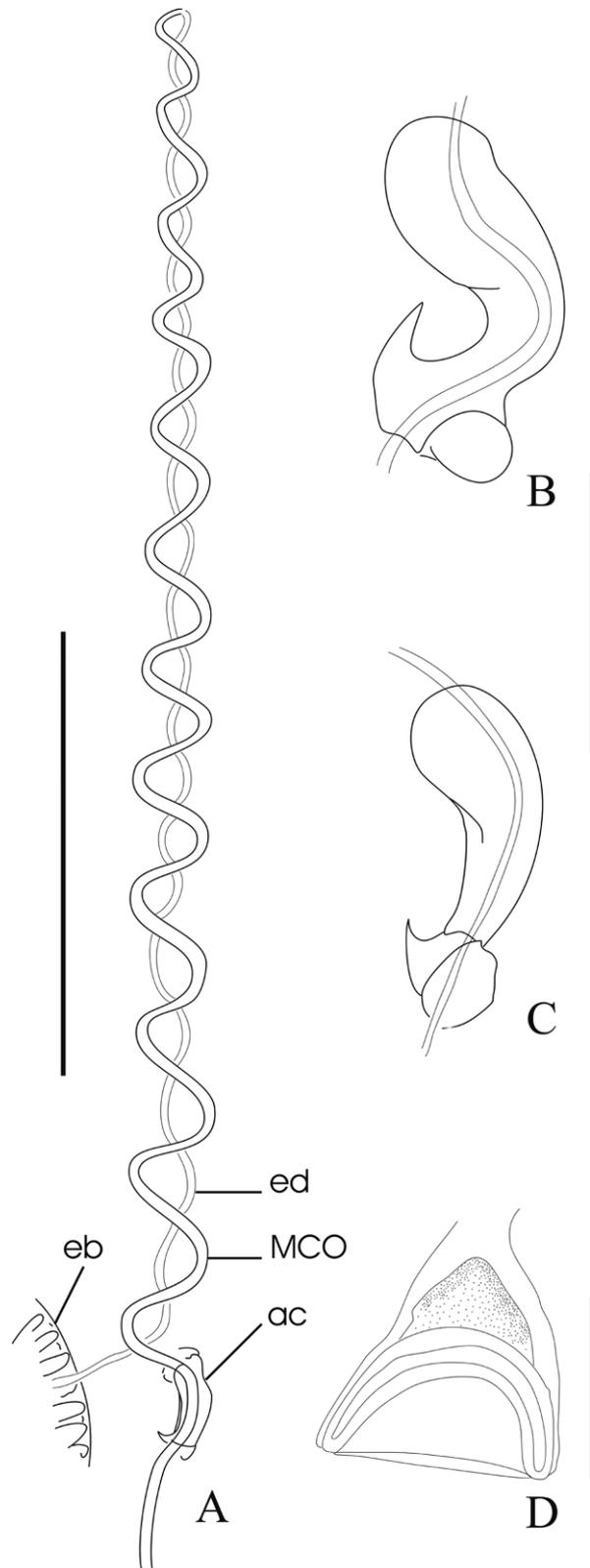


Fig. 3. *Monocotyle myliobatis* Taschenberg, 1878. **A** – spiral male copulatory organ (ac – accessory piece, eb - ejaculatory bulb, ed – ejaculatory duct, MCO – male copulatory organ); **B-C** – slight variations of accessory piece according to orientation and specimens; **D** – vaginal sclerite. Scale bars = 200 μ m (A), 100 μ m (B, C, D)

Specimens deposited: 1 neotype: Muséum National d'Histoire Naturelle, Paris, HEL N° 178 (Tf 197); 9 paraneotypes: Muséum National d'Histoire Naturelle, Paris, HEL N° 179 (Tf 198); N° 200 (Tf 199); N° 201 (Tf 200); N° 202 (Tf 201); N° 203 (Tf 202); N° 204 (Tf 203); N° 205 (Tf 204); N° 206 (Tf 205); N° 207 (Tf 206); British Natural History Museum, London, N° 2011.1.20.1-4.

Remarks: Species of *Monocotyle* have been distinguished by the morphology and by the size of the anchor, which vary from 50 (*M. multiparous*) to 560 (*M. corali*).

Among the 18 *Monocotyle* species currently known (Portes Santos *et al.* 2006), *M. myliobatis* resemble *M. corali* and *M. undosocirrus* based upon the morphology and size of the anchors (over 500 long). It differs from *M. corali* by the total number of haptoral papillae (80 *vs* 64), the number of papillary sclerites (3 *vs* 2) and the number of loops of MCO (12 *vs* 9). It differs from *M. undosocirrus* by the number and size of the papillary sclerites (3 *vs* 2) and the number of loops of the MCO (12 *vs* 6). *M. myliobatis* also resembles *Monocotyle* sp. A Chisholm, 1995 from *Dasyatis fluviorum* by its morphology and size of the anchors (525) which show a long and striated handle, but differs from it by the number of loops of the MCO (12 *vs* 6). However, according to Chisholm *et al.* (1995), the two available specimens of this species “are not in good condition and the haptor and anatomy are unknown”.

Perugia and Parona (1890) then Palombi (1942) described the anchor of *M. myliobatis* with a bifurcate handle. Such morphology was used by Chisholm (1998) as an original trait of *M. myliobatis* in the key of *Monocotyle*. In our study, we did not observed anchors with a bifurcate handle. The handle of anchors appears gently striated in all our specimens. This morphology might simulate a division of the handle. According to Chisholm (1998), the handle of the anchors of *M. corali* has a striated pattern but less marked than in *M. myliobatis*. The anchors of two other species: *M. pricei* from *Dasyatis sabina* and *M. diademalis* from *D. say*, that one of us (L.E.), have examined living on the Atlantic coast (Charleston S.C), have a solid handle.

All *Monocotyle* haptors have an outer rim septum (ORS) armed with one row of “Type A” sclerites. Each sclerite is disposed at the basis of one haptoral papillae, with the exception of the haptor of *M. myliobatis* in which two “Type A” sclerites are disposed at the basis of one haptoral papillae. Among the Monocotylineae only *Dendromonocotyle pipina* Chisholm et Whittington, 2004 has been described with such disposition.

Discussion

In the revision of Monocotylidae, Chisholm *et al.* (1995) combined Monocotylineae with Dendromonocotylineae into a single subfamily defined by the uniquely derived and easily visible septal and papillary haptoral sclerites. This decision has supported by molecular analysis (Chisholm *et al.* 2001).

This subfamily includes three genus *Monocotyle*, *Dendromonocotyle* Hargis, 1955 and *Clemacotyle* Young, 1967.

Since the type material of *M. myliobatis*, type species of the genus, has disappeared and the description of this monogenean by Perugia and Parona (1890) and Palombi (1949) was incomplete, Chisholm (1998) suggested that more material should be collected from the type host, preferably from the type locality, to confirm the morphology of *M. myliobatis*. Further the morphology of the MCO needed to be established because it has not been described adequately. Our detailed re-description of *M. myliobatis* collected in the Mediterranean Sea on the type host *Myliobatis aquila* allows us to provide a revised diagnosis for *Monocotyle*.

Monocotyle Taschenberg, 1878

Haptor with one central and eight peripheral loculi, each separated by eight radial septa. Marginal membrane present. Marginal haptoral papillae present. Haptoral septa and papillae armed with sclerites. One posterior anchor in each posterolateral septum. Haptoral dorsal protuberances present or not. 14 uncinuli (seven pairs) symmetrically distributed in marginal membrane. Anterolateral gland duct openings numerous. Two intestinal caecum smooth or irregularly constricted, not confluent posteriorly. Genital pore medioventral. One or three testes. Left vas deferens. Male copulatory organ tubular sclerotised, simple or spiralling. MCO accessory piece present, or absent. Ovary elongate, sinuous, looping around right intestinal caecum. Vagina single, unarmed, opening ventrally on left side of body. Vaginal wall unsclerotized or sclerotised. Additional vaginal sclerite sometimes present in proximal portion of vagina. Eggs tetrahedric.

Type-species: *Monocotyle myliobatis* Taschenberg, 1878.

Other species: *Monocotyle ijimae* Goto, 1894; *M. pricei* Pearse, 1949; *M. spirophallus* (Tripathi, 1959) Timofeeva, 1984; *M. diademalis* Hargis, 1955; *M. granulatae* Young, 1967; *M. kuhlii* Young, 1967; *M. tritestis* Young, 1967; *M. ancylostomae* Timofeeva, 1984; *M. undosocirrus* Timofeeva, 1984; *M. helicophallus* Measures, Beverley-Burton et Williams, 1990; *M. multiparous* Measures, Beverley-Burton et Williams, 1990; *M. spiremae* Measures, Beverley-Burton et Williams, 1990; *M. corali* Chisholm, 1998; *M. jordani* Chisholm, 1998; *M. youngi* Chisholm, 1998; *M. caseyae* Chisholm et Whittington, 2005; *M. guttatae* Portes Santos, Santos et Gibson, 2006.

The hosts of these *Monocotyle* belong to various families of elasmobranchs (Gymnuridae, Rhynchobatidae, Myliobatidae), although the majority (12/18) belong to Dasyatidae. *M. myliobatis* and *M. corali* (from *Myliobatis australis*), are the only two species reported from a Myliobatidae.

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