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Neotropical Monogenoidea. 19. Dactylogyridae of Cichlids (Perciformes) from the Yucatán Peninsula, with Descriptions of Three New Species of *Sciadicleithrum* Kritsky, Thatcher, and Boeger, 1989

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ABSTRACT: Three new species of *Sciadicleithrum* are described from the gills of cichlids from the Yucatán Peninsula in North America: *Sciadicleithrum mexicanum* sp. n. from "*Cichlasoma*" *urophthalmus* (Günther); *Sciadicleithrum bravohollisae* sp. n. from "*C.*" *pearsei* (Hubbs) (type host), "*C.*" *synspilum* Hubbs, and *Petenia splendida* Günther; and *Sciadicleithrum splendidae* sp. n. from *P. splendida. Cichlidogyrus sclerosus* Paperna and Thurston, 1969, is reported from the gills of *Oreochromis niloticus* (Linnaeus), an introduced fish in Mexico.

KEY WORDS: Mexico, Monogenoidea, Dactylogyridae, *Sciadicleithrum, Sciadicleithrum mexicanum* sp. n., *Sciadicleithrum bravohollisae* sp. n., *Sciadicleithrum splendidae* sp. n., *Cichlidogyrus sclerosus, "Cichlasoma" urophthalmus, "Cichlasoma" pearsei, "Cichlasoma" synspilum, Petenia splendida, Oreochromis niloticus.*

Members of the Dactylogyridae (Polyonchoinea, Dactylogyridea) have been reported as parasites of cichlid fishes from nearly throughout their hosts' geographic range. *Gussevia* Kohn and Paperna, 1964, *Sciadicleithrum* Kritsky, Thatcher, and Boeger, 1989, and *Trinidactylus* Hanek, Molnar, and Fernando, 1974, are restricted to and include the only known Dactylogyridae (Ancyrocephalinae) infesting Neotropical Cichlidae (see Kritsky et al., 1986, 1989). In continental Africa, native cichlids support species of *Cichlidogyrus* Paperna, 1960, *Onchobdella* Paperna, 1968, and *Enterogyrus* Paperna, 1963, and in Madagascar species of *Insulacleidus* Rakotofiringa and Euzet, 1983 (see Paperna, 1979; Rakotofiringa and Euzet, 1983). Asian cichlids are parasitized by species of *Ancyrocephalus* Creplin, 1839 (sensu lato), *Ceylonotrema* Gussev, 1963, and *Enterogyrus* (see Gussev, 1963).

During surveys of helminth parasites of fishes from the Yucatán Peninsula, 3 undescribed species of *Sciadicleithrum* were recovered from the gills of native North American cichlids. In addition, a species of *Cichlidogyrus,* apparently introduced with its host from Africa, was found. These geographic and host records, descriptions of the new species of *Sciadicleithrum* and a brief discussion of origin and speciation of *Sciadicleithrum* species in Central America are provided herein.

Materials and Methods

Cichlid[1] hosts, "*Cichlasoma*" *urophthalmus,* "*C.*" *synspilum,* "*C.*" *pearsei, Petenia splendida,* and *Oreochromis niloticus,* were collected from several localities on the Yucatán Peninsula during 1989–1992. Methods of collection, preparation, measurement, and illustration of helminths were those described by Kritsky et al. (1986). In addition, some specimens were fixed in Bouin's, stained with Gomori's trichrome and mounted in Canada balsam; others were cleared in lactophenol and mounted unstained in glycerine jelly. Measurements are in micrometers; the mean is followed by the range and number (*n*) of specimens measured in parentheses. Type specimens are deposited in the helminthological collections of the U.S. National Museum (USNM), Beltsville, Maryland, and the University of Nebraska State Museum (HWML), Lincoln; vouchers of each species are in the Coleccion Helmintológica del Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico.

Sciadicleithrum mexicanum sp. n. (Figs. 1–8)

DESCRIPTION (based on 50 specimens): Body 320 (245–398; $n = 24$) long, *fusiform; greatest* width 76 (59–117; $n = 25$) near midlength or in

[1] Stiassny (1991) suggested that cichlid species formerly included in *Cichlasoma* and now lacking formal generic placement as a result of Kullander's (1983) revision of the genus should be referred to by the generic name in quotes until phylogenetic analysis of the group allows formal generic assignment.

posterior trunk. Cephalic lobes moderately developed. Eyes 4; members of posterior pair with conspicuous lens, larger, closer together than members of anterior pair; eye granules variable in size, elongate ovate; accessory granules in cephalic region, uncommon in anterior trunk. Pharynx spherical, 18 (15–20; n = 20) in diameter; esophagus moderately long. Peduncle broad; haptor subhexagonal, 75 (55–98; n = 25) wide, 59 (50–70; n = 26) long. Ventral anchor 33 (29–35; n = 22) long, with short deep root, tapering superficial root, shaft and point with longitudinal lateral grooves; base width 16 (15–17; n = 17). Dorsal anchor 39 (35–41; n = 19) long, with slightly appressed roots, shaft and point with longitudinal lateral grooves; base width 14 (13–16; n = 16). Ventral bar 34 (30–37; n = 21) long, robust, with enlarged ends; dorsal bar 31 (29–33; n = 21) long, broadly V-shaped rod with enlarged ends. Hooks similar; each 15 (14–17; n = 71) long, with upright thumb, delicate point, shank varying in diameter along length; domus ⅔ shank length. Gonads slightly overlapping. Testis 61 (50–72; n = 13) × 27 (24–32; n = 11), elongate ovate; apparent seminal vesicle elongate fusiform, with thick wall; prostatic reservoir saccate. Coil of male copulatory organ loose, comprising about 0.5 poorly defined ring, frequently appearing U-shaped; base of copulatory organ with sclerotized margin; copulatory organ length 62 (53–68; n = 17). Accessory piece 45 (37–52; n = 12) long, comprising delicate sheath enclosing copulatory organ, terminating in diagonal opening. Germarium 32 (27–43; n = 12) × 21 (14–25; n = 11), with irregular margin; oviduct, ootype, uterus not observed; vagina dextral, distal opposing funnel-shaped sclerites guarding aperture; seminal receptacle midventral, small; vitellaria dense throughout trunk, except absent in regions of reproductive organs.

HOST AND LOCALITIES: Gills of "*Cichlasoma*" *urophthalmus* (Günther); Progreso (type) and Rio Lagartos, Yucatán, Mexico, and Champotón, Atasta, and Laguna Silvituc, Campeche, Mexico.

SPECIMENS STUDIED: Holotype, USNM 82796; 49 paratypes, USNM 82797, HWML 36295–36299.

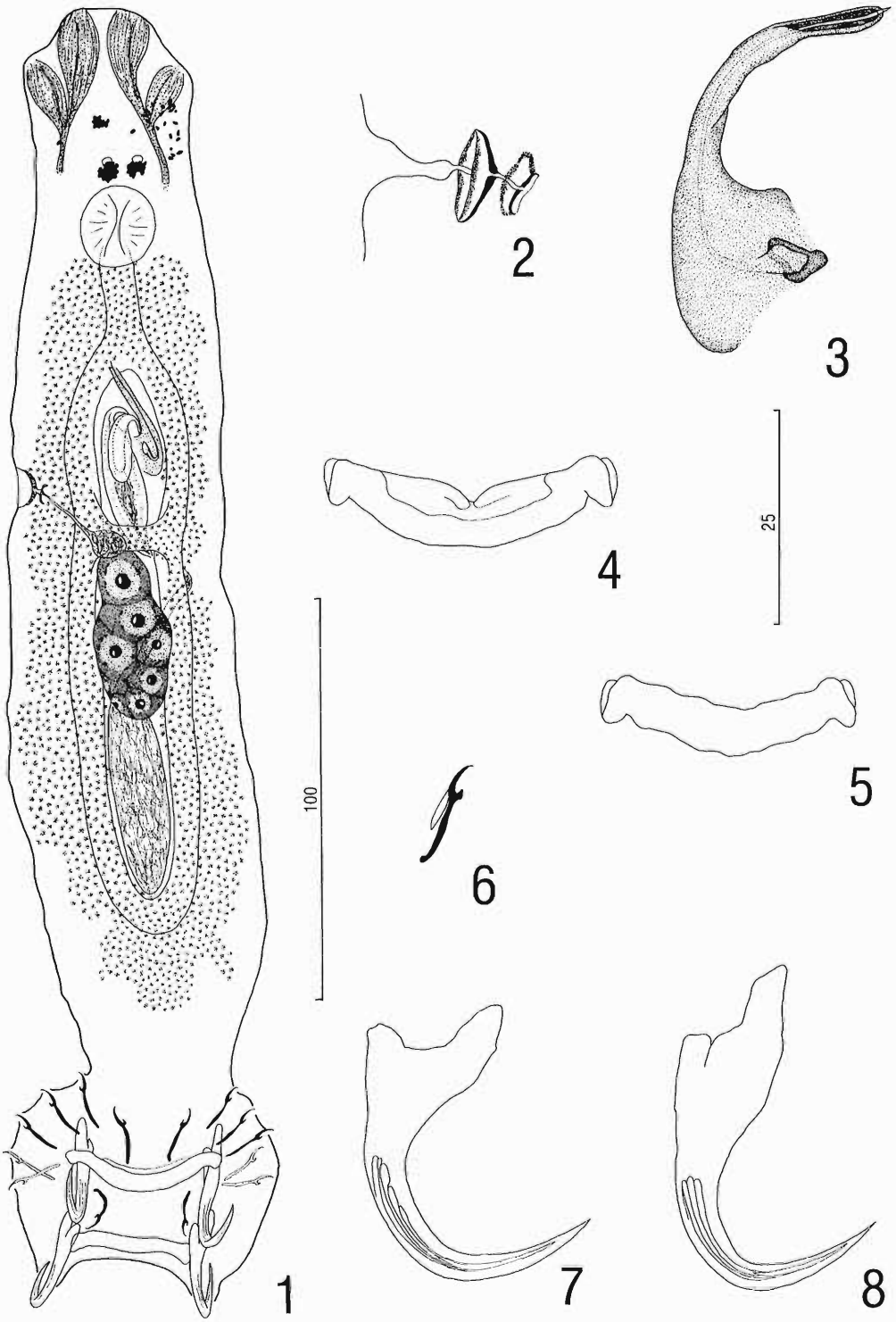
REMARKS: *Sciadicleithrum mexicanum* most closely resembles *S. bravohollisae* sp. n. Both species possess dorsal and ventral anchors with longitudinal lateral grooves on the shafts and points, dorsal anchors with appressed roots, gonads slightly overlapping or tandem, vaginae with opposing "funnel-shaped" sclerites near their apertures, accessory pieces comprising delicate sheaths enclosing the distal portions of the U-shaped shafts of the male copulatory organs, and thickened walls of the apparent seminal vesicles. *Sciadicleithrum mexicanum* differs from *S. bravohollisae* by having a male copulatory organ with a thin shaft and simple base lacking a proximal lobed projection and a more delicate vaginal sclerotization. This species is named for the country from which it was collected.

Sciadicleithrum bravohollisae sp. n. (Figs. 9–17)

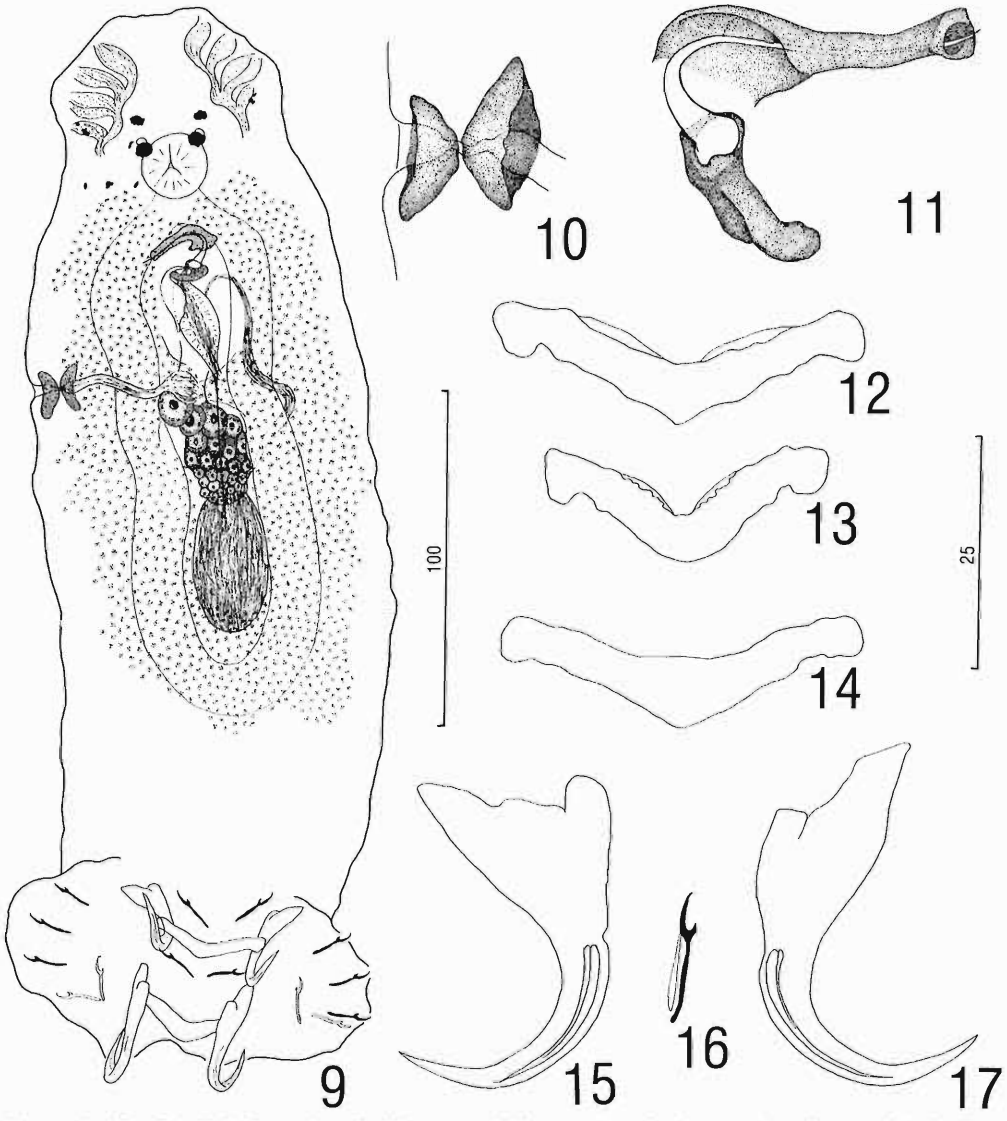
DESCRIPTION (based on 16 specimens from "*Cichlasoma*" *pearsei*; comparative measurements by host presented in Table 1): Body stout; greatest width near midlength. Cephalic margin broad; cephalic lobes moderately developed. Eyes 4; members of posterior pair with conspicuous lens, larger, closer together than members of anterior pair; eye granules variable in size, usually elongate ovate; accessory granules in cephalic, anterior trunk regions. Pharynx spherical; esophagus short (contracted specimens) to moderately long. Peduncle broad; haptor subovate. Ventral anchor with short roots, shaft and point with longitudinal lateral grooves. Dorsal anchor with slightly appressed roots, shaft and point with longitudinal lateral grooves. Ventral bar yoke-shaped, with delicate umbelliform membranes; dorsal bar expanded medially, with slightly enlarged ends. Hooks similar; each with upright thumb, delicate point, shank; domus $^{9}/_{10}$ shank length. Gonads slightly overlapping. Testis ovate; apparent seminal vesicle with thick wall, fusiform; prostatic reservoir fusiform. Coil of male copulatory organ loose, comprising less than 1 poorly defined ring; shaft of copulatory organ proximally tapered; base with sclerotized margin, lobed proximal projection. Accessory piece comprising variable sheath enclosing distal shaft of copulatory organ. Germarium with irregular margin; oviduct, ootype, uterus not observed; vagina dextral, with 2 opposing funnel-shaped distal sclerites, opening into small medial seminal receptacle; vitellaria dense throughout trunk, except absent in regions of reproductive organs.

TYPE HOST AND LOCALITY: Gills of "*Cichlasoma*" *pearsei* (Hubbs); El Vapor Lagoon, Campeche, Mexico.

OTHER RECORDS: Gills of "*Cichlasoma*" *synspilum* Hubbs; El Vapor Lagoon and Atasta,



Figures 1–8. ***Sciadicleithrum mexicanum*** **sp. n. 1. Composite illustration of entire specimen (ventral). 2. Vaginal aperture and sclerotization. 3. Copulatory complex. 4. Ventral bar. 5. Dorsal bar. 6. Hook. 7. Ventral anchor. 8. Dorsal anchor. All drawings are made to the 25-μm scale except Figure 1 (100-μm scale).**



Figures 9–17. ***Sciadicleithrum bravohollisae*** **sp. n. 9. Ventral view of entire specimen (composite). 10. Vaginal aperture and sclerotization. 11. Copulatory complex. 12, 13. Ventral bars. 14. Dorsal bar. 15. Ventral anchor. 16. Hook. 17. Dorsal anchor. All drawings are to the 25-μm scale except Figure 9 (100-μm scale).**

Campeche, Mexico. Gills of *Petenia splendida* Günther; El Vapor Lagoon, Campeche, Mexico.

SPECIMENS STUDIED: Holotype, USNM 82794; 15 paratypes, USNM 82795, HWML 36289; 13 vouchers (from "*C.*" *synspilum*), HWML 36290, 36291; 2 vouchers (from *Petenia splendida*), HWML 36292.

REMARKS: *Sciadicleithrum bravohollisae* resembles *S. mexicanum* sp. n. Morphologic details separating them are presented in the remarks for *S. mexicanum*. This species is named for Dr. M. Bravo-Hollis, Universidad Nacional Autonoma de Mexico, in appreciation and recognition of her significant contributions to present understanding of the Monogenoidea of Central and North America.

Sciadicleithrum splendidae sp. n. (Figs. 18–24)

DESCRIPTION (based on 2 specimens): *Body 250* ($n = 1$) long, with parallel lateral margins; greatest width 83 (74–92; $n = 2$). Cephalic lobes moderately developed. Eyes 4; members of posterior pair with conspicuous lens, larger, closer together

Table 1. Comparative measurements (in micrometers; mean with range in parentheses; *n* = number of specimens measured) of *Sciadicleithrum bravohollisae* from 3 different hosts collected from the Yucatán Peninsula, Mexico.

	"Cichlasoma" pearsei	*n*	*"Cichlasoma" synspilum*	*n*	*Petenia splendida*	*n*
Body length	391 (296–558)	8	401 (307–580)	5	515 (508–522)	2
Greatest width	103 (80–121)	9	140 (136–155)	6	101 (79–123)	2
Pharynx	22 (20–25)	7	23 (22–27)	6	21 (17–25)	2
Haptor length	72 (57–89)	9	65 (62–66)	5	70	1
Haptor width	97 (83–111)	8	103 (92–120)	5	79	1
Dorsal anchor length	41 (39–44)	7	33 (30–35)	5	30	1
Dorsal anchor width	17 (14–18)	7	17 (16–18)	3	16	1
Ventral anchor length	36 (34–39)	6	28–29	3	27	1
Ventral anchor width	22 (21–24)	6	19 (18–20)	3	17	1
Dorsal bar length	32 (30–33)	6	31 (30–32)	6	30	1
Ventral bar length	31 (28–34)	5	29 (27–32)	6	28	1
Hook length	16 (14–17)	27	15 (14–16)	21	15–16	3
Male copulatory organ length	54 (45–60)	7	53 (50–58)	4	—	0
Accessory piece length	39 (31–45)	4	31 (26–37)	5	—	0
Germarial length	38 (27–53)	7	43 (24–84)	6	62	1
Germarial width	19 (16–23)	7	30 (20–43)	6	20	1
Testis length	45 (36–57)	5	45 (31–64)	5	—	0
Testis width	27 (23–30)	5	30 (27–39)	5	—	0

than members of anterior pair; eye granules variable in size, irregular to elongate ovate; accessory granules in cephalic, trunk regions. Pharynx subspherical, 20 (n = 1) in diameter. Peduncle broad; haptor subtrapezoidal, 77 (n = 1) wide, 62 (n = 1) long. Ventral anchor 32 (n = 1) long, with short deep root, protruding superficial root, shaft and point with longitudinal lateral grooves; base width 17 (n = 1). Dorsal anchor 40 (n = 1) long, with slightly appressed roots, shaft and point with longitudinal lateral grooves; base width 14 (n = 1). Ventral bar 39 (38–40; n = 2) long, robust, with enlarged ends; dorsal bar 37–38 (n = 2) long, broadly V-shaped. Hooks similar; each 15–16 (n = 6) long, with upright thumb, delicate point, shank; domus ¾ shank length. Gonads slightly overlapping. Testis 47 (n = 1) × 22 (n = 1), elongate ovate; seminal vesicle, prostatic reservoir not observed. Coil of male copulatory organ loose, comprising about 2.5 rings; base of copulatory organ with sclerotized margin, bilobed proximal branch; length of copulatory organ 230 (228–233; n = 2), proximal ring diameter 31 (27–35; n = 2). Accessory piece 22 (n = 1) long, comprising delicate sheath enclosing subterminal portion of shaft of copulatory organ. Germarium 30 (n = 1) × 21 (n = 1), subovate; oviduct, ootype, uterus not observed; vagina dextral, a dilated tube looping anteriorly to level of copulatory complex, with distal funnel guarding aperture; seminal receptacle dextromedial, small; *vitellaria* dense throughout trunk, except absent in regions of reproductive organs.

HOST AND LOCALITY: Gills of *Petenia splendida* Günther; El Vapor Lagoon, Campeche, Mexico.

SPECIMENS STUDIED: Holotype, USNM 82793; paratype, HWML 36293.

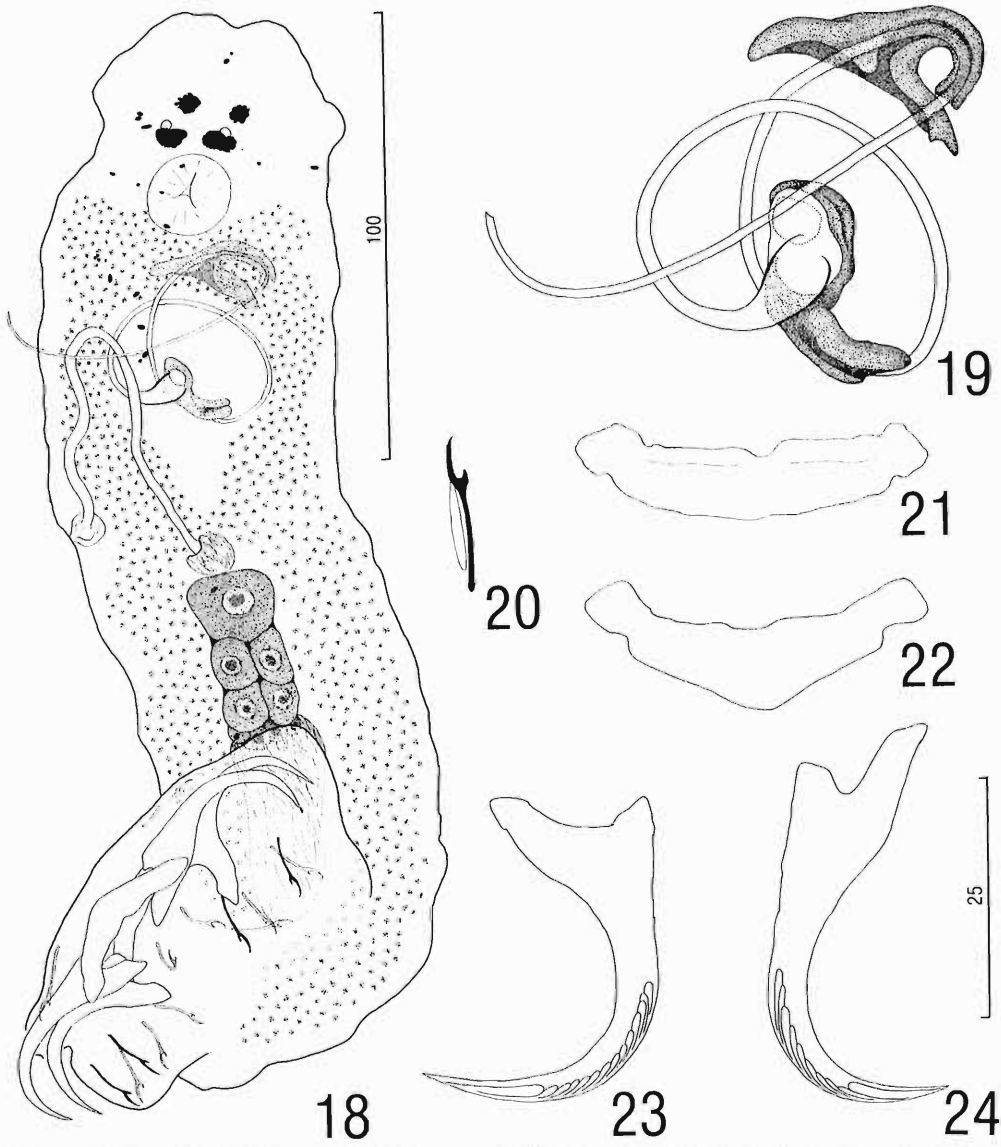
REMARKS: Only 2 specimens of this species were found on 1 specimen of *Petenia splendida.* Both specimens were mounted unstained in Gray and Wess' medium, which precluded complete study of the internal anatomy. Nonetheless, morphology of haptoral and copulatory sclerites clearly indicate that these specimens comprise an undescribed species of *Sciadicleithrum* with affinities to *S. bravohollisae* and *S. mexicanum* spp. n. This species differs from *S. bravohollisae* and *S. mexicanum* by possessing an elongate vaginal canal lacking a "double funnel" sclerotization of its external aperture, dorsal anchors with comparatively elongate straight shafts, and a coiled male copulatory organ with more than 1 complete ring. The specific name is derived from that of its host.

Cichlidogyrus sclerosus Paperna and Thurston, 1969

HOST AND LOCALITY: Gills of *Oreochromis niloticus* (Linnaeus); Laguna Noh-Bek, Quintana Roo, Mexico.

SPECIMENS STUDIED: Two vouchers, HWML 36294.

MEASUREMENTS: Pharyngeal diameter 40 (35–45; n = 2); ventral anchor length 28 (n = 1), width 18 (n = 1); dorsal anchor length 25 (n = 1), width 16 (n = 1); ventral bar length 41 (n =



Figures 18–24. ***Sciadicleithrum splendidae*** **sp. n. 18. Holotype (ventral view); haptor (dorsal view) folded ventrally. 19. Copulatory complex. 20. Hook. 21. Ventral bar. 22. Dorsal bar. 23. Ventral anchor. 24. Dorsal anchor. All drawings are to the 25-μm scale except Figure 18 (100-μm scale).**

1); dorsal bar length 31 (n = 1); length of male copulatory organ 55 (n = 1); accessory piece length 43 (42–45; n = 2); egg length 55 (n = 1), width 39 (n = 1).

REMARKS: *Cichlidogyrus sclerosus,* a natural parasite of cichlids in Africa, was first reported from the Western Hemisphere by Kritsky and Thatcher (1974) on *Oreochromis mossambicus* (Peters) (=*Tilapia mossambica*) from Colombia. The parasite has subsequently been reported repeatedly from Cuba on *O. aureus* by Vinjoy et al. (reported in Prieto et al., 1985) and on *O. aureus, Sarotherodon hornorum,* and hybrids of *O. mossambica* [*sic*] × *S. hornorum* by Prieto et al. (1985) and Prieto and Fajer (1987). Martínez (1980) reported *Cichlidogyrus* sp. on tilapia roja [*sic*] in Cuba (paper not seen by present authors; reported in Prieto et al., 1985); this report probably included *C. sclerosus.* All reported occurrences of *C. sclerosus* in the Western Hemisphere apparently are results of concomitant human introductions of the parasite and its hosts.

Discussion

Although some Central American fish species clearly have their origins within North America, the fish fauna of this region is dominated by forms with evolutionary links to South America. The invasion of Central America by South American fishes probably occurred more than once (cf. Rosen, 1975), with that of the cichlids preceding the dispersal of primary freshwater fishes into the area (Myers, 1966). According to Myers (1966), evolution of "*Cichlasoma*" (and of its relatives) in Central America has been rapid since invasion, which probably occurred during the Miocene or late Oligocene. Miller (1966) listed 68 described species of Central American "*Cichlasoma*" occurring south of the Isthmus of Tehuantepec in Mexico.

Sciadicleithrum includes a group of 12 described species infesting gills of New World Cichlidae in the Amazon Basin and Guyana (Kritsky et al., 1989) and Central America (nobis). Although species of this genus have not previously been reported as parasites of *Cichlasoma* in South America, Central American species of *Sciadicleithrum* are clearly more closely related to each other than to any known South American species, suggesting that they have undergone speciation since dispersal of a common ancestor to the area. Among apparent synapomorphic characters supporting sister relationships of Central American *Sciadicleithrum* are (a) the longitudinal lateral grooves on the shafts and points of the ventral and dorsal anchors, (b) the sheathlike accessory piece, (c) the slightly overlapping or tandem gonads, (d) the slightly appressed roots of the dorsal anchors, and (e) the thickened walls of what appears to be the seminal vesicle.

Species of *Sciadicleithrum* apparently have experienced a parallel evolutionary history with that of their hosts in Central America. Although they may be assigned to the South American–Caribbean generalized distributional tract defined by Rosen (1975), it is not presently clear whether the *Sciadicleithrum* clade in Central America represents descendants from early or late invasions to the area because surveys for dactylogyrids infesting cichlids of the Antilles and Mexico north of the Isthmus of Tehuantepec are lacking. If *Sciadicleithrum* does not occur in the Antilles and northern Mexico, the distribution would suggest 2 possibilities: (a) that it entered Central America during late invasions predicted by Rosen's (1975) vicariance model, or (b) that ancestral *Sciadicleithrum* reaching Central America during the early wave(s) of dispersal experienced subsequent extinction within the Antilles after relative displacement eastward had effectively separated the Antillian area from Central America. The latter scenario is not unlikely, because extinction rates are presumed to be locally high as historical geographic ranges fragment or dispersal to new areas occurs (Wilson, 1992). If, however, *Sciadicleithrum* species are found in either the Antilles or northern Mexico, the new distribution would support early dispersal of the taxon to Central America.

It is apparent that further survey of Dactylogyridae infesting cichlids in South and Central America and both the Greater and Lesser Antilles will be necessary to understand the evolutionary history of *Sciadicleithrum*. Knowing the parasites harbored by cichlids occurring north of the Isthmus of Tehuantepec might provide insight on the temporal aspects of invasion by their ancestors. Absence of a phylogenetic hypothesis for members of all dactylogyrid genera infesting cichlids in the New World also limits our ability to determine potential coevolutionary relationships of these parasites and their hosts in the region.

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