

Gulf and Caribbean Research

Volume 17 | Issue 1

January 2005

Argulus yucatanus N. Sp. (Crustacea: Branchiura) Parasitic on *Cichlasoma urophthalmus* from Yucatan, Mexico

William J. Poly
California Academy of Sciences

DOI: 10.18785/gcr.1701.01

Follow this and additional works at: <http://aquila.usm.edu/gcr>

 Part of the [Marine Biology Commons](#)

Recommended Citation

Poly, W. J. 2005. *Argulus yucatanus* N. Sp. (Crustacea: Branchiura) Parasitic on *Cichlasoma urophthalmus* from Yucatan, Mexico. *Gulf and Caribbean Research* 17 (1): 1-13.

Retrieved from <http://aquila.usm.edu/gcr/vol17/iss1/1>

This Article is brought to you for free and open access by The Aquila Digital Community. It has been accepted for inclusion in *Gulf and Caribbean Research* by an authorized editor of The Aquila Digital Community. For more information, please contact Joshua.Cromwell@usm.edu.

ARGULUS YUCATANUS N. SP. (CRUSTACEA: BRANCHIURA) PARASITIC ON CICHLASOMA UROPTHALMUS FROM YUCATAN, MEXICO

William J. Poly

California Academy of Sciences, 875 Howard Street, San Francisco, California 94103 USA,
E-mail wpoly@calacademy.org

ABSTRACT A new species, *Argulus yucatanus*, is described based on 14 specimens from *Cichlasoma urophthalmus* collected in Celestun Lagoon, Yucatan, Mexico. Diagnostic characters include the number of and shape of sclerites in the suction cup support rods, shape of and position of respiratory areas, and modifications on the legs of males. In males, the coxae of the 2nd legs bear an angular lobe with 5–7 erect scales and 13–21 sensilla. The new species is compared to *Argulus funduli* Krøyer, 1863, *A. chromidis* Krøyer, 1863, *A. cubensis* Wilson, 1936, *A. rhamdiae* Wilson, 1936, and *A. varians* Bere, 1936.

RESUMEN Una nueva especie, *Argulus yucatanus*, está escrito de catorce especímenes de *Cichlasoma urophthalmus* colectaron del Estero de Celestún, Yucatán, México. Varios caracteres la distinguen con inclusión del número de y de la forma de escleritos en las rayas de las ventosas, de las áreas respiratorias y de las modificaciones en las patas de los machos. En los machos, las segundas parejas de las patas tienen un lóbulo angular con 5–7 escamas erguidas y 13–21 sensillas. *Argulus funduli* Krøyer, 1863, *A. chromidis* Krøyer, 1863, *A. cubensis* Wilson, 1936, *A. rhamdiae* Wilson, 1936 y *A. varians* Bere, 1936 están comparado a la nueva especie.

INTRODUCTION

Only 3 species of *Argulus* have been described from Mexico (Wilson 1936a, Pineda et al. 1995, Poly 2003), namely *A. rhamdiae* Wilson, 1936, *A. mexicanus* Pineda, Páramo and Del Rio, 1995, and *A. ambystoma* Poly, 2003. In addition, 4 other species of *Argulus* have been listed as components of the Mexican fauna (see Poly 2003). The present study includes a description of one new species from Mexican waters and comparisons of the new species with other species that are either similar to it in some features or that occur in the region. Also, new data and illustrations are included for 2 poorly known species, *A. chromidis* Krøyer, 1863 and *A. cubensis* Wilson, 1936.

MATERIALS AND METHODS

All specimens were fixed and stored in 4% formalin in 1994 and were transferred to 70% ethanol in 1998. Six females and 8 males (13 mature, 1 immature male) were examined under dissecting and compound microscopes in a watchglass or as a temporary slide mount (with 70% ethanol and Hoyer's medium). Drawings were made with the aid of a camera lucida. All measurements were made using an ocular micrometer, and measurements reported below are arranged as follows: range (mean, holotype) with allotype values substituted for females. Width of first antennae refers to the distance from the mesial margin of the basal segment to the farthest extent of bend in the terminal spine on the 2nd segment. Two males and one female also were examined using scanning electron microscopy, and preparation procedures were modified

slightly from those of Rupp (1990). Specimens were dehydrated in an ethanol series consisting of 80% (5 min), 90% (5 min), 100% (1st, 5 min; 2nd, 10 min), then critical point dried, mounted on metal stubs with carbon paint, allowed to dry in an oven (60 °C), and sputter coated with gold/palladium. Type specimens were deposited in the American Museum of Natural History, New York (AMNH), in the Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ), and in the author's collection. The syntypes of *A. funduli* (ZMUC CRU-6473, 4 males, 2 females [data collected from 2 males and 2 females]), the holotype of *A. chromidis* (ZMUC CRU-6030, 1 female, poor condition) (both from the Zoologisk Museum, Copenhagen, Denmark), and the syntypes, along with other specimens, of *A. cubensis* (MCZ 8973 [syntypes], 1 male, 1 female; MCZ 9643 [non-types], 2 females) were examined for comparison with the new species using the methods described above. Information about *A. varians* was obtained from literature sources (Bere 1936, Bouchet 1985).

RESULTS

Family Argulidae Rafinesque, 1815

***Argulus* Müller, 1785**

***Argulus yucatanus*, n. sp.**

Yucatan fishlouse

Figures 1–7, Tables 1–2

Material examined. Holotype—adult male, 2.83 mm total length, AMNH Crustacea 18469, Estero de Celestún (Celestun Lagoon), Yucatán, México, 4 November 1994,

collector: Frantizek Moravec. Allotype: adult female, 3.33 mm total length, AMNH Crustacea 18470. Other paratypes: 1 adult male, 1 adult female, AMNH Crustacea 18471; 2 adult males, 1 immature male, 2 adult females, MCZ 50725; 3 adult males, 2 adult females (includes SEM specimens), author's collection; all paratypes collected with holotype.

Diagnosis. Two respiratory areas with smaller, circular to ovoid "area" anterior to larger posterior "area;" postantennal spines single; males with 37–46 support rods per suction cup; females with 43–51 support rods per suction cup; usually 2–3 sclerites per rod in males, 3–5 sclerites per rod in females; mouth tube with 2–5 (usually 4) scales on basal half; bushy fringe of fine setae on margin of labium; basal plate of 2nd maxilla with 3 stout, digitate spines, larger scales on anterior of pad with smaller scales posteriorly, scales round to ovoid with coarse-pectinate margin, 3–8 stout, naked setae on posterior margin of pad; first 2 pairs of legs lacking flagella; posteroventral surface of coxae of 2nd legs of males with an angular, fleshy lobe bearing 5–7 erect scales on posterior margin and 13–21 sensilla; 3rd legs of males with 2 ornamented pegs issuing from cleft on dorsal side of legs; male abdomen much longer and narrower than female abdomen; spermathecae of female ovate, relatively large; testes of male extend entire length of abdomen; caudal rami long, slender, basal in anal sinus.

Description. Total length (mm) 2.17–3.38 (2.88, 2.83) in males, 2.80–3.88 (3.40, 3.33) in females. Carapace shape as shown in Figures 1A, B, with cephalic region distinctly separated from alae. Carapace length (mean of both alae, mm) 1.30–2.00 (1.73, 1.69) in males, 1.95–2.67 (2.42, 2.39) in females. Maximum carapace width (mm) 1.18–2.00 (1.68, 1.65) in males, 1.75–2.55 (2.21, 2.12) in females. Carapace extending as far as anterior margin of to middle of 3rd legs in males, as far as anterior margin of 3rd legs to anterior margin of 4th legs in females. Females with eggs in thorax but not in carapace alae. Sensilla and pores scattered on dorsal surface and margins of carapace; fringe of small sensilla with larger sensilla interspersed along cephalic margin of carapace. Pair of compound eyes anteriorly with diameters (left and right eyes, μm) 100–150 (122, left: 110, right: 110) in males, 120–150 (130, left: 130, right: 130) in females. Transverse distance between eyes (μm) 340–510 (421, 420) in males, 480–630 (558, 520) in females. Nauplius eye with one anterior and 2 posterior ocelli. Sclerotized dorsal ridges not forked anterior of eyes. Ventrally, carapace with small, posteriorly-projecting spines along outer margin, more numerous anterior of respiratory areas with few spines occurring beyond anterior margin of larger res-

piratory area. Respiratory areas consist of smaller, circular to ovoid "area" anterior to larger, posterior ovoid "area" (Figures 1C–E); respiratory areas not outlined with pigment (possibly lost in preservative). Color in preservative white to light yellow; no other pigmentation present (possibly lost in preservative).

Thorax compressed dorsoventrally, 4-segmented, with 2 pairs of posteriorly-projecting spines ventrally. Spines digitate, anterior pair (accessory spines) usually larger than posterior pair (postmaxillary spines). Accessory spines between basal segments of 2nd maxillae. Postmaxillary spines farther apart than accessory spines. Males with ovoid fleshy lobe at posterior of 4th thoracic segment between natatory lobes (Figures 2A, B). Thorax with coarse-pectinate scales scattered on ventral surface (Figure 2A). Dorsal surface of thorax with sensilla; typically one sensillum at midline of posterior margins of 2nd and 3rd thoracic segments with others variously placed (Figure 2C). Four pairs of biramous swimming legs composed of a precoxa, coxa, basis, exopod, and endopod (Figure 2A). Exopods and endopods with plumose setae. Setae usually absent from coxae of 2nd and 3rd legs; see Table 1 for number of setae on legs. First 2 pairs of legs lacking flagella. Endopods of first pair of legs 3-segmented with 3 setae distally. Endopods of 2nd pair of legs unsegmented. Endopods of 3rd and 4th pairs of legs 2-segmented. Second, 3rd, and 4th legs of males with secondary sexual structures (Figure 2A). Coxae of male 2nd legs with an angular, fleshy lobe posteroventrally with 5–7 (6, 7) erect scales on posterior margin and 13–21 (17, 19–21) sensilla (Figure 2D); number of erect scales on angular lobe excludes prostrate coarse-pectinate scales present on ventral surface of coxae. Dorsal surface of coxae of male 3rd legs covered with closely-arranged fine-pectinate scales (Figures 1A, 2E). Two ornamented pegs issue dorsally from joint between coxa and basis of male 3rd legs with fine-pectinate feather-like scales posterior and ventral to the pegs (Figures 2E, F, 3A, B). Pegs with horn dorsally; orifice of pegs containing many bi-pronged and multi-pronged projections from inner wall. Dorsal surface of pre-coxae of male 3rd legs with many small sensilla. Bases of male 4th legs with 2 opposing blunt lobes on anterior surface; dorsal lobe with scaled area anteriorly (non-pectinate scales) and small patch of tubercles distally (Figures 3C, D). Precoxae and coxae of male and female 4th legs with posterior natatory lobes fringed with plumose setae and bearing scales and sensilla. Female natatory lobes with more scales and sensilla than those of male. Bases of 4th legs of both sexes larger than bases of other legs. Coarse-pectinate scales on ventral surfaces of pre-coxae and coxae (Figure 3E).

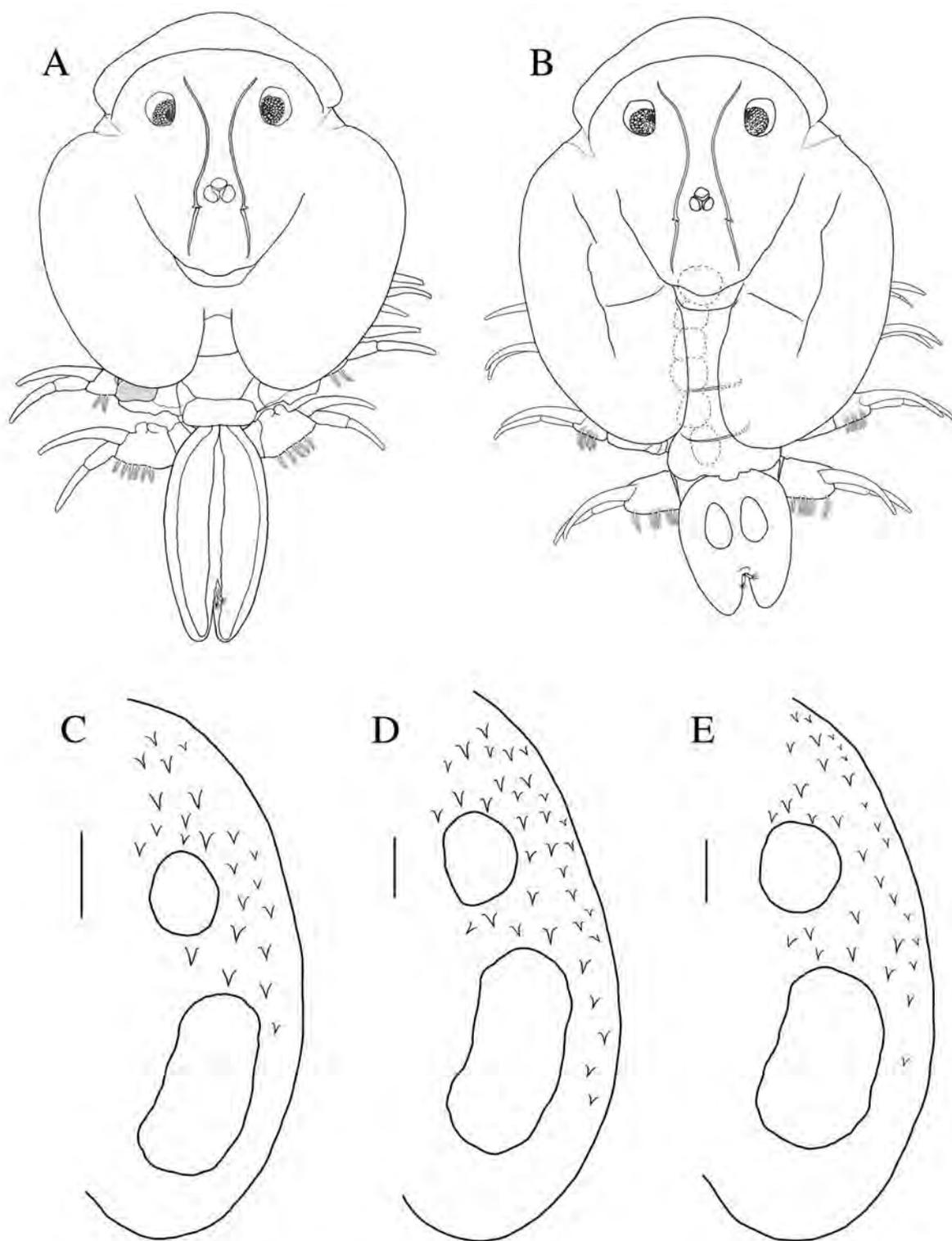


Figure 1. *Argulus yucatanus*, n. sp. A) Male, dorsal view (holotype, 2.83 mm total length, AMNH Crustacea 18469). B) Female, dorsal view (allotype, 3.33 mm total length, AMNH Crustacea 18470). C–E) Shape of respiratory areas and distribution of adjacent spines on: C) holotype (male), D) allotype (female), E) paratype (female, AMNH Crustacea 18471). For clarity, plumose setae were not shown on endopods and exopods of legs (1A, B). Number of setae illustrated on bases is actual number present on these particular specimens (1A, B); dorsal and ventral rows of setae can be seen on the bases of 3rd legs (1B). Eggs in thorax shown by dashed lines (1B). Scale: C–E = 200 μ m.

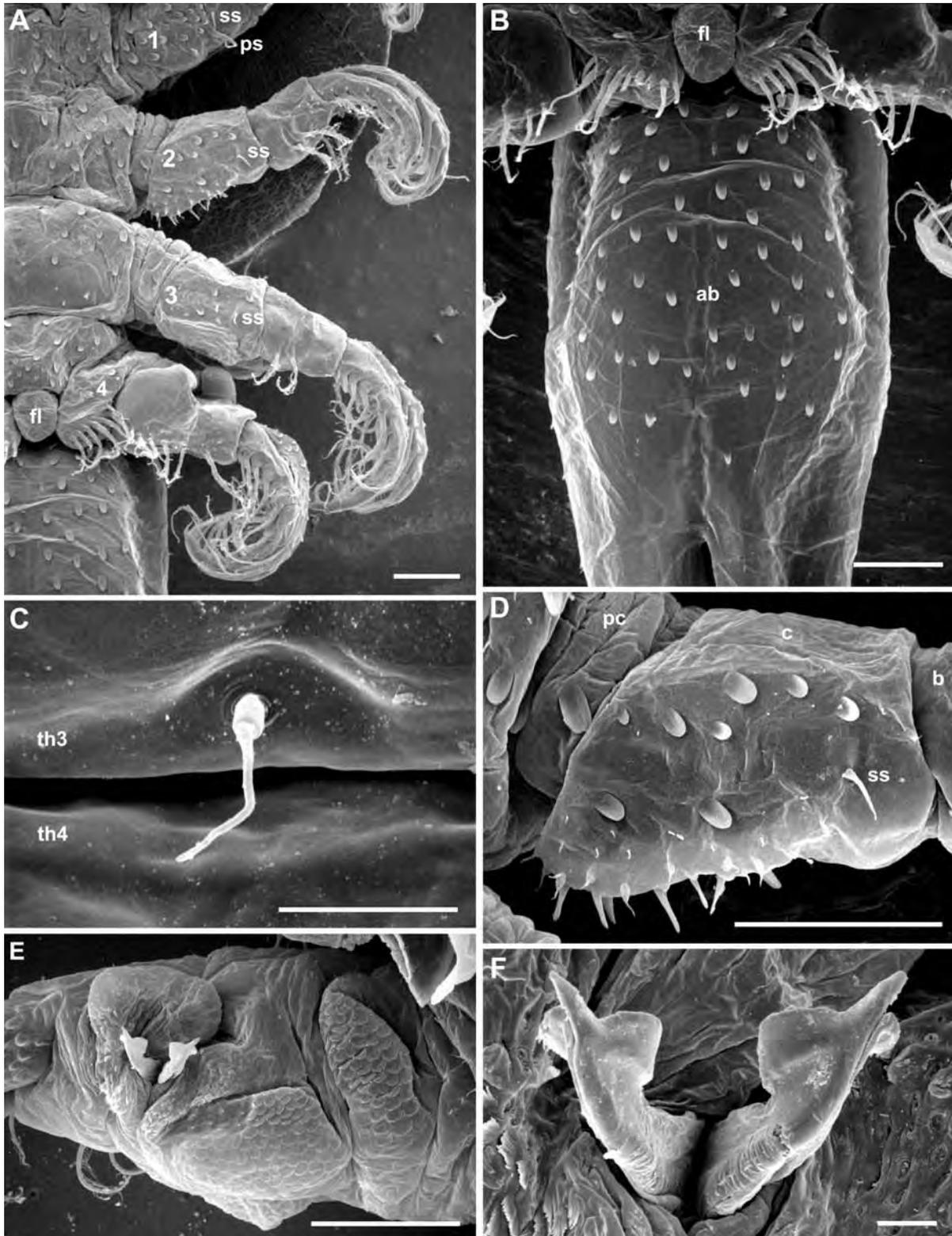


Figure 2. *Argulus yucatanus*, n. sp. (males). A) Ventral view of legs, thorax, and abdomen; legs numbered 1–4 on coxae, ss = simple seta, ps = plumose seta, fl = fleshy lobe. B) Distribution of scales on ventral surface of abdomen (ab) and fleshy lobe (fl) between natatory lobes. C) Sensillum at midline of thorax at posterior margin of 3rd thoracic segment (th3), extending over 4th thoracic segment (th4). D) Angular, fleshy lobe on coxa of 2nd leg (ventral view); pc = precoxa, c = coxa, b = basis, ss = simple seta. E) Pair of pegs and fine-pectinate scales covering portions of coxa of 3rd leg (dorsal view). F) Close-up of pegs on 3rd leg (dorsal view). Scale: A, B, D, E = 100 μ m; C, F = 10 μ m.

TABLE 1

Number of setae on coxae and bases of legs of *Argulus yucatanus*, n. sp. Separate counts of both right and left legs for each individual were included (8 males, 6 females; range followed by mean in parentheses). Most setae were plumose; some setae have small plumes and sometimes appeared simple. There is usually a single, simple seta or sensillum not associated with the others on the coxae and bases of legs 1–3, and these were not included in the counts.

		Coxa (Ventral)	Basis (Ventral)	Basis (Dorsal)
Leg 1	Male	1–2 (1)	2–4 (3)	0
	Female	1 (1)	2–3 (3)	0
Leg 2	Male	0–1 (0) ^a	1–3 (3)	1–4 (3)
	Female	0	2–4 (3)	3–5 (4)
Leg 3	Male	0	1–2 (2)	0
	Female	0	2–4 (3)	3–4 (4)
Leg 4	Male	6–10 (8)	4–6 (5)	0
	Female	13–23 (20)	6–10 (8)	0

^aOnly one of 16 legs from 8 specimens with a seta; setae usually not present on segment

Abdomen bilobate. Each lobe with single row of small, coarse-pectinate scales along posterolateral edges and small sensilla near tips and along lateral margins in both sexes. Male abdomen longer and narrower than female abdomen (Figures 1A, B). Abdomen length (mm) 0.76–1.09 (0.99, 1.00) in males, 0.68–0.93 (0.83, 0.82) in females; maximum width (mm) 0.45–0.55 (0.50, 0.49) in males, 0.46–0.71 (0.64, 0.65) in females. Anal sinus length (μm) 200–320 (282, 290) in males, 290–340 (318, 320) in females. Caudal rami paired, long, slender, at base of anal sinus; each ramus with 5 stout, naked “setae” (Figure 3F). Spermathecae of female paired, brownish, ovate, relatively large, located anteriorly on abdomen (Figure 1B). Abdominal papillae absent on female abdomen. Testes of male occupy much of abdomen, extending entire length of abdominal lobes (Figure 1A). Abdomen of male with coarse-pectinate scales on ventral surface anterior of anal sinus (Figure 2B).

First antennae 4-segmented. First segment (basal segment) sclerotized, large with stout posteriorly-projecting posterior spine; 2nd segment sclerotized with small recurved spine anteriorly, posteriorly-projecting medial spine, and large recurved terminal spine; 3rd segment fleshy, cylindrical with large, stout seta distally that projects ventrally and several smaller setae; 4th segment fleshy, small, with few setae distally (Figures 4A, B). Width of first antennae (mean of both antennae, μm) 210–280 (256, 255) in males, 280–360 (330, 325) in females. Second antennae 5-segmented, fleshy. First 2 segments larger; remaining 3 thin, cylindrical; basal segment bears posteriorly-projecting posterior spine. All segments of 2nd antennae with several long, stout setae that project distally; some

reaching to or beyond junction with next segment. Postantennal spines single (as opposed to double in some taxa), large, rounded or pointed distally (Figures 4A, B).

First maxillae modified into suction cups in adults. In males, first maxillae inner diameter (μm) 220–290 (241, left: 230, right: 220) ($n = 14$, left and right) and outer diameter (μm) 310–420 (352, left: 350, right: 340) ($n = 14$). In females, inner diameter (μm) 370–450 (428, left: 410, right: 410) ($n = 12$, left and right) and outer diameter (μm) 500–650 (595, left: 570, right: 570) ($n = 12$). See Table 2 for number of support rods in suction cups. Number of sclerites per support rod in males 1–4 (2, 2, range 1–3) ($n = 596$ support rods) and in females 1–5 (4, 4, range 1–5) ($n = 549$ support rods). Usually 2–3 sclerites per rod in males, 3–5 sclerites per rod in females; lower counts such as one due to missing sclerite(s) or atypical development, uncommon. Number of sclerites variable with position on suction cup; shape of sclerites variable; orientation of rods changes at 2 points on rim of suction cup (Figure 5, see Discussion). Basal (proximal) sclerite usually rod-shaped, longer than other sclerites. Distal sclerites bowl- or cylinder-shaped. Suction cups with 9–15 (12, 12) sensilla on inside circumference; sensilla with pore at tip and with or without tentacles distally (Figures 6A–C). Short, conical sensilla, with pore distally, on rim of suction cup between basal sclerites of some support rods (Figures 6A, D).

Second maxillae 5-segmented with broad basal plate bearing 3 stout, digitate spines, usually larger space between lateral spine and central spine (Figures 6E, F). Basal plate with elevated pad bearing 3–4 large (anteriorly) and more smaller coarse-pectinate scales and 3–8 stout setae that

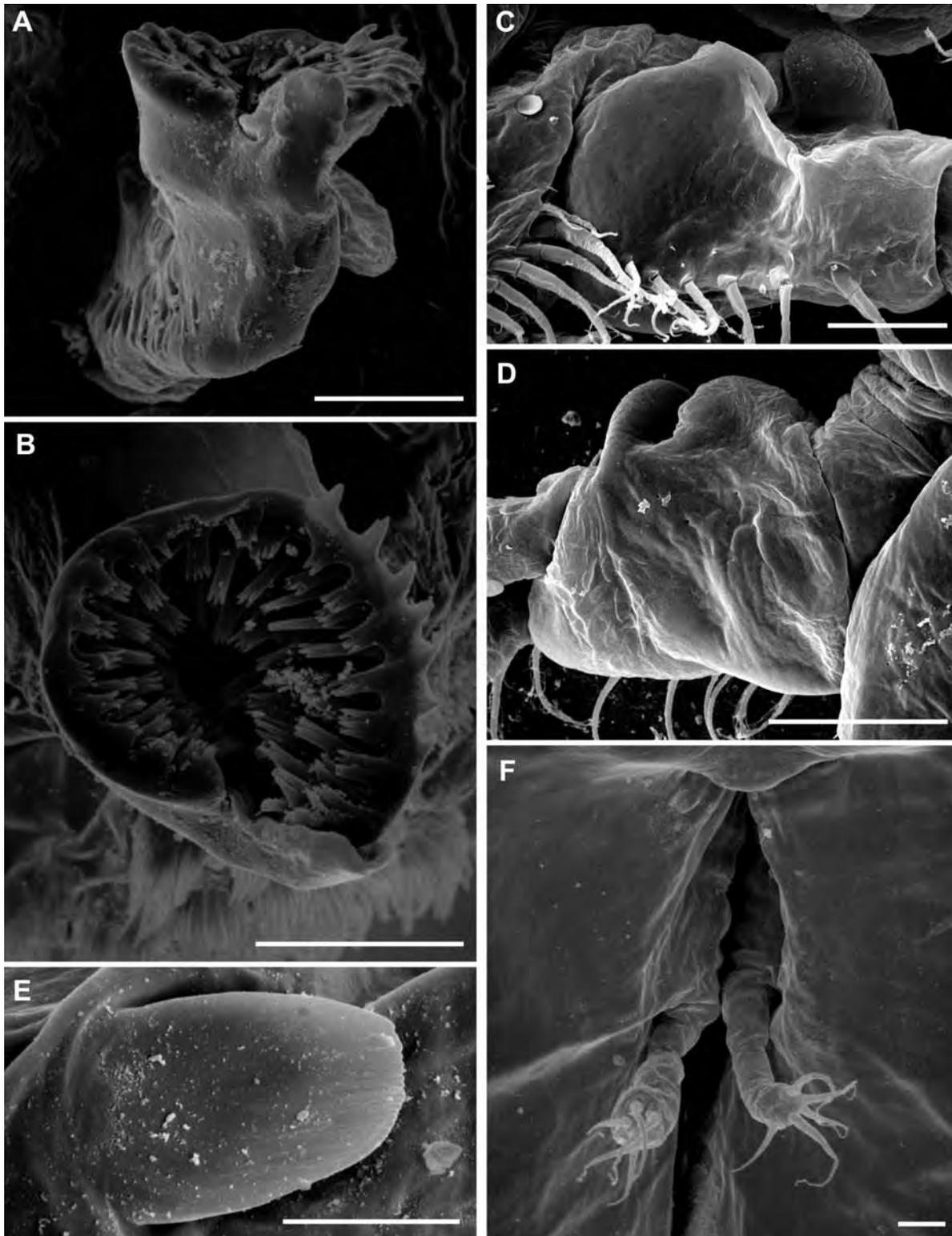


Figure 3. *Argulus yucatanus*, n. sp. (males). A) Peg on 3rd leg (dorsal view), rotated partially toward anterior face. B) Anterior face of a peg illustrating detail of ornamentation; note feather-like scales below the peg. C) Ventral view of basis of 4th leg with 2 opposing lobes, one of which has a scaled area anteriorly (non-pectinate scales) and patch of small tubercles distally. D) Dorsal view of basis of 4th leg. E) Coarse-pectinate scale on base of mouth tube; this is the typical coarse-pectinate scale found on ventral side of thorax, mouth tube, coxae, and basal plate of 2nd maxillae of both sexes and ventral side of abdomen of males. F) Caudal rami at base of anal sinus of abdomen (dorsal view, male). Scale: A, B, E, F = 10 μ m; C = 50 μ m; D = 100 μ m.

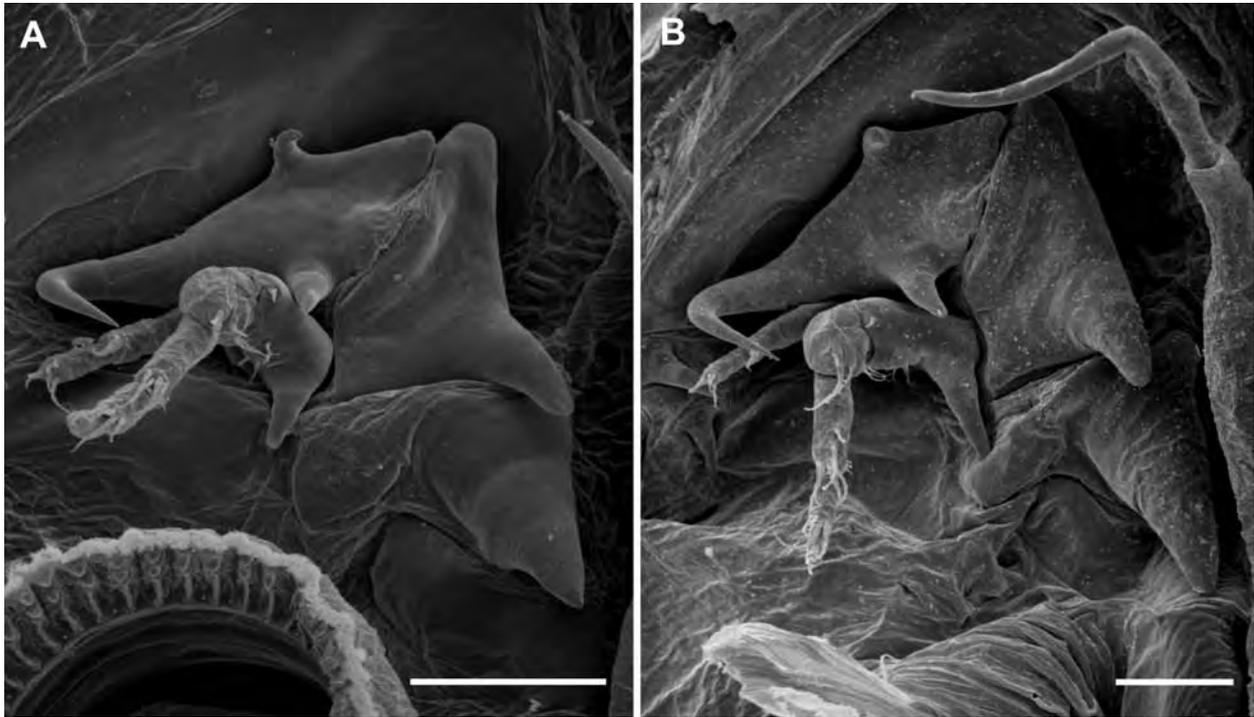


Figure 4. *Argulus yucatanus*, n. sp. A, B) First and 2nd antennae and postantennal spine (ventral view; A, male; B, female). Scale: A, B = 100 μ m.

extend posteriorly, usually over space between central and lateral posterior spines (Figures 6E, F). Scales and setae/sensilla on ventral surfaces of last 4 segments. Distal segment with 2 sharp claws and 1 blunt, elongate lobe positioned above claws, with small sensillum at tip of lobe.

Mouth tube of moderate length, usually not reaching thoracic accessory spines, with 2–5 (usually 4) scales on basal half (Figures 3E, 7A). Labium with fringe of fine setae around mouth (Figures 7A, B); labrum with embedded scales around mouth (Figure 7C). Two pairs of sensilla on both labium and labrum; 3 other pairs of similar structures on mouth tube (Figure 7B). Pair of serrated mandibles and pair of labial ducts inside mouth tube (Figure 7C). Preoral stylet present, when extended usually reaching as far as area anterior of first antennae nearly to anterior margin of carapace (Figure 4C). Short projections and orifice near tip of stylet (Figure 7D).

Host. *Cichlasoma urophthalmus* (Günther), Mayan cichlid.

Etymology. The specific name, *yucatanus*, is derived from the state in which the type locality is located (Yucatan, Mexico) and is treated herein as a noun in apposition.

Remarks. Male *A. yucatanus* and *A. funduli* Krøyer, 1863 are quite similar in the shapes of the cephalic region, carapace, and abdomen as seen from a dorsal view; however, *A. yucatanus* can be distinguished from *A. funduli* by the much lower number of sclerites in the suction cup support rods (2–5 vs. 11–26, respectively ($n = 4$, *A. funduli*, mean = 17; 290 rods)), and *A. yucatanus* also has fewer support rods per suction cup than *A. funduli* (37–51 vs. 53–64, respectively ($n = 4$, *A. funduli*, mean = 58; 8 suction cups)). *Argulus yucatanus* has a pair of accessory spines and a pair of postmaxillary spines, whereas *A. funduli* lacks both pairs of spines. *Argulus funduli* has more

TABLE 2

Number of support rods in first maxillae (suction cups) of male and female *Argulus yucatanus*, n. sp. (numbers for holotype and allotype in bold). ^aNot counted

	Male ($n = 8$)							Female ($n = 6$)						
Left Suction Cup	37	42	41	44	45	42	46	40	51	46	43	49	48	44
Right Suction Cup	42	44	43	43	43	43	42	— ^a	48	48	46	47	47	46
	$\bar{x} = 43$; Range = 37–46							$\bar{x} = 47$; Range = 43–51						
	$\bar{x} = 44$; Range = 37–51 (male and female)													

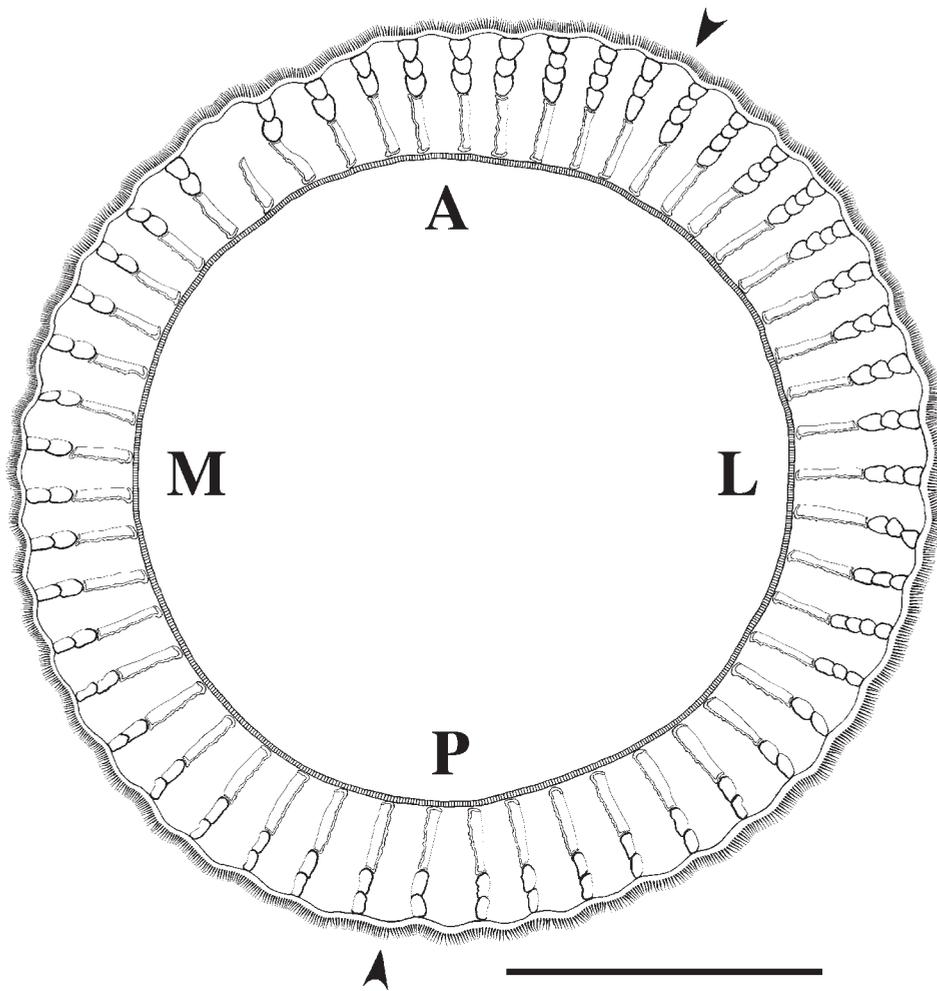


Figure 5. *Argulus yucatanus*, n. sp. Suction cup (first maxilla) rim, support rods, and fringe of setae (allotype, AMNH Crustacea 18470, left side); arrows indicate points at which orientation of rods changes; A = anterior, P = posterior, L = lateral, M = medial. Note missing sclerites in one rod. Scale: 200 μ m.

scales on the mouth tube than *A. yucatanus*. Male *A. funduli* do not have the secondary sexual modification on the coxae of the 2nd legs as do male *A. yucatanus*. The shape and position of the respiratory areas are similar, but not identical, between the 2 species, and both differ in features of the basal plate of the 2nd maxilla.

Argulus varians Bere, 1936 resembles *A. yucatanus* in shapes of the cephalic region and carapace, absence of flagella on legs, and number and shape of sclerites in suction cup rods, but they can be distinguished from each other by the size of and shape of the respiratory areas and differences in the shape of the abdomen. The natatory lobes of female *A. varians* possess a projection posterolaterally that is not present on the natatory lobes of female *A. yucatanus*, and the spermathecae of *A. varians* differ from those of *A. yucatanus*, following information given in Bere (1936) and Bouchet (1985). Male *A. varians* differ from male *A. yucatanus* in the secondary sexual modifications on the legs.

Argulus chromidis and *A. cubensis* both have flagella on the first 2 pairs of legs, round spermathecae, and eggs in the carapace alae of gravid females (in addition to those in the thorax); however, Krøyer (1863) exaggerated the egg distribution in the carapace of *A. chromidis* in his drawing (the hexagonal pattern on the specimen). In addition, the number of setae on leg segments, shape of respiratory areas, shape of body, and features of the 2nd maxillae of both species differ markedly from *A. yucatanus* (Figures 8B, C, E, F). Secondary sexual modifications on the legs of male *A. cubensis* differ from those of male *A. yucatanus*. *Argulus cubensis* has 39–49 support rods ($n = 4$, *A. cubensis*, mean = 45; 7 suction cups) and 4–6 sclerites per rod (mean 4, 217 rods; Figure 8D). *Argulus chromidis* lacks armature on the mouth tube, and the single suction cup available for *A. chromidis* had 42 support rods and 3–5 sclerites per rod (mean = 4; 41 rods; Figure 8A). The brief description of *Argulus rhamdiae* (based on a single female) does not agree with *A. yucatanus* in body shape,

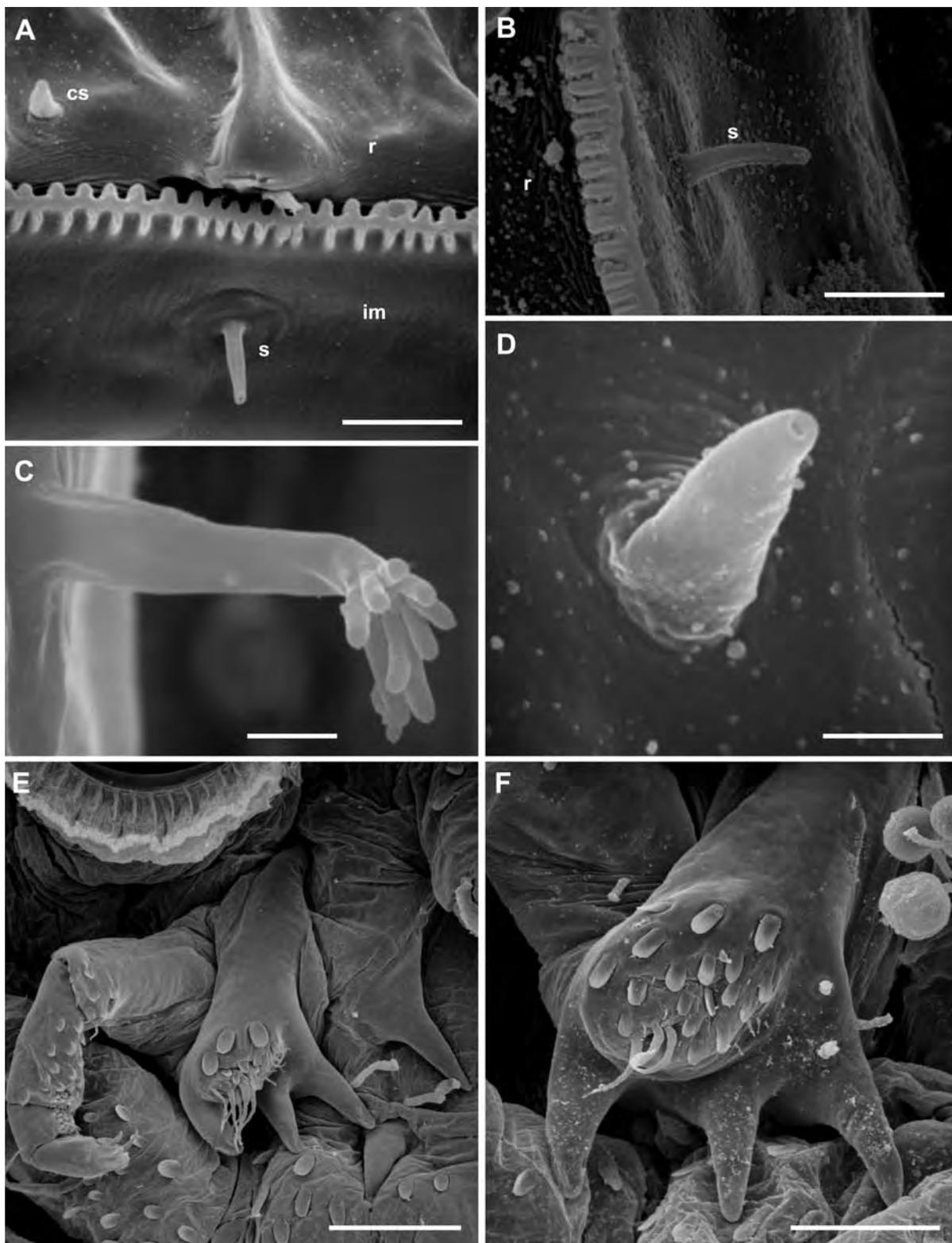


Figure 6. *Argulus yucatanus*, n. sp. A) Conical sensillum (cs) and sensillum (s) on rim (r) and inner margin (im), respectively, of suction cup (male); note pore at tip of sensillum on inner margin of suction cup. B) Sensillum (s) on inner margin of suction cup; r = rim of suction cup (female). C) Sensillum with tentacles distally on inner margin of suction cup (male). D) Close-up of conical sensillum near basal sclerite on rim of suction cup (male); note pore at tip. E) Second maxilla, accessory spine, and post-maxillary spine (male, right side). F) Basal plate of 2nd maxilla and adjacent stalked protozoan parasites at upper right (female, right side). Scale: A, B = 5 μm ; C, D = 1 μm ; E, F = 100 μm .

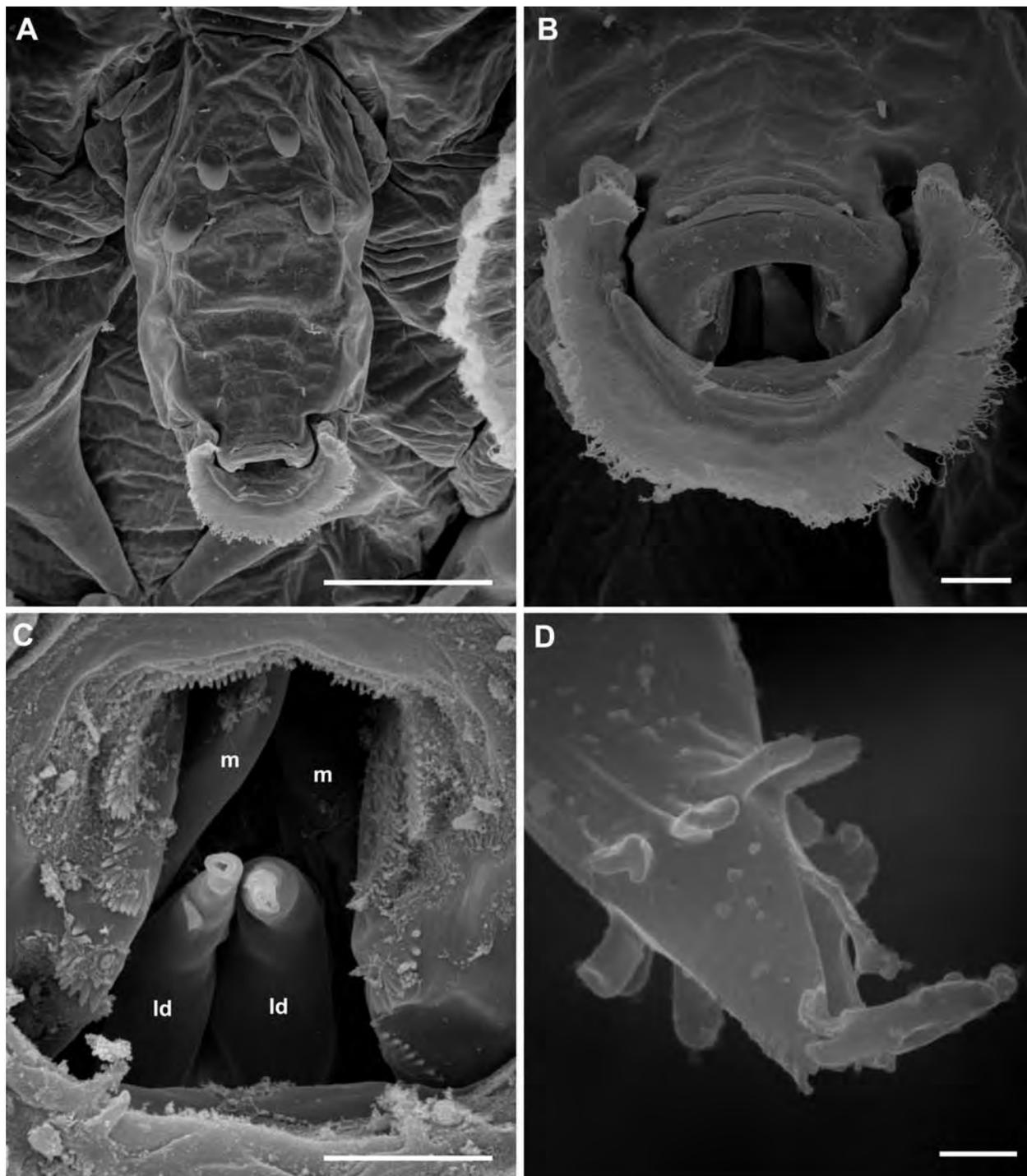


Figure 7. *Argulus yucatanus*, n. sp. A) Mouth tube with 4 scales on basal portion (male). B) Mouth tube; note dense fringe of fine setae along margin of labium and sensilla on mouth tube, labium, and labrum (male). C) Labial ducts (ld) and mandibles (m) inside mouth (female); note openings at tips of labial ducts. D) Tip of preoral stylet with protuberances and opening (male). Scale: A = 50 μ m; B, C = 10 μ m; D = 1 μ m.

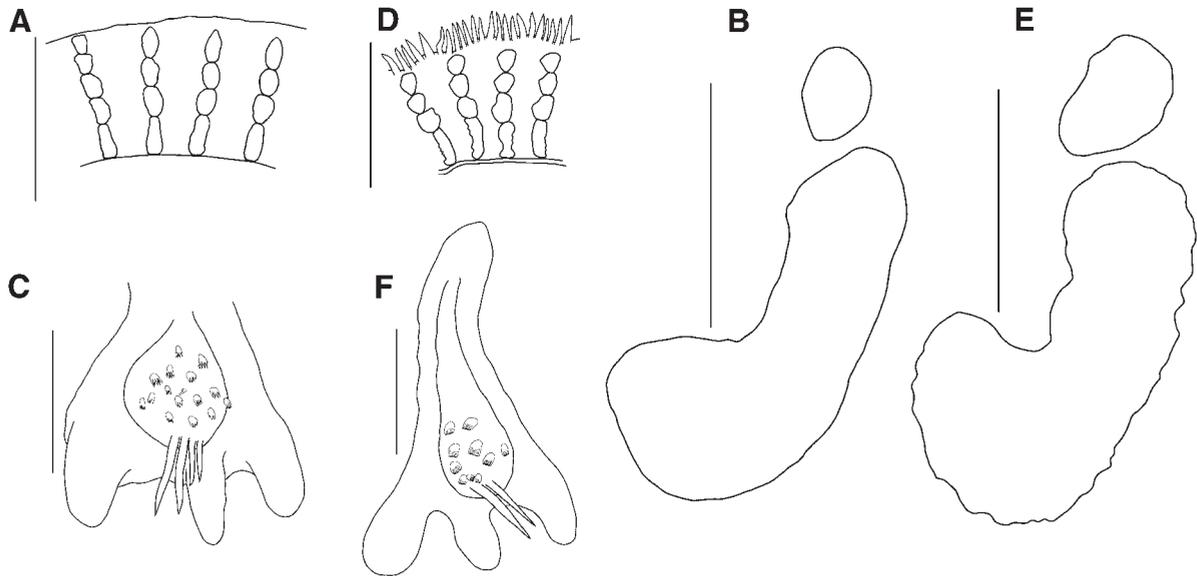


Figure 8. *Argulus chromidis* (holotype, female, ZMUC CRU-6030). A) Support rods from anterolateral portion of suction cup (fringe of setae not shown). B) Respiratory areas. C) Basal plate of left 2nd maxilla. *Argulus cubensis* (syntype, male, MCZ 8973). D) Support rods and fringe of setae from anterolateral portion of suction cup. E) Respiratory areas; note that scalloped appearance is an artifact of preservation and distortion. F) Basal plate of right 2nd maxilla. Scale: A, C, D, F = 100 μm ; B, E = 500 μm .

characters of 2nd maxillae, shape of sclerites in suction cup support rods, or size and shape of spermathecae according to information given in the original description (see Wilson, 1936a); however, the type specimen of *A. rhamdiae* could not be located for direct comparison.

DISCUSSION

Variation in number of and shape of sclerites was observed on *A. yucatanus* as was noted for several other species (Fryer 1959, Avenant-Oldewage and Oldewage 1995, Poly 2003; Figure 5). In *A. yucatanus* higher numbers of sclerites per rod occur in the anterolateral section of a suction cup and the sclerites tend to be more bulbous or round anterolaterally, whereas sclerite numbers are lower posteriorly and on mesial (inner) margin, and sclerites tend to be more slender. There also is a bilateral division of the suction cups that can be seen in the orientation of the rods, particularly the basal sclerites, and this has not been pointed out previously for any argulid. The orientation changes at 2 points, anterolaterally and posteromesially, and at one of these points, the thickened, uneven edges of the basal sclerites face one another, whereas at the opposite point, the thin edges face (Figure 5). This same type of change in orientation of the rods has been observed in other *Argulus* spp. (e.g., *A. cubensis*, Figure 8D), but not all species have this feature (W. Poly pers. obs.). For *A.*

yucatanus the number of rods on each “half” of a suction cup, as divided by the change in orientation, usually are not equal, with a slightly higher number occurring on the mesial side (means of 24 vs. 20). The bilateral division probably is an expression of normal bilateral symmetry of the body present in many metazoan phyla, although being slightly asymmetrical in this case. Cunnington (1931:262) illustrated 4 suction cup support rods of *Argulus carteri* Cunnington, 1931, showing the change in orientation at one point on a suction cup (his Plate 15, Figure 14), stating only that “... the apparently meaningless variations of these chitin rays afford additional evidence which it would be unwise to ignore.”

Argulus yucatanus is the eighth *Argulus* species known to occur in Mexico. None of the other *Argulus* spp. that parasitize cichlids in the Gulf of Mexico and Caribbean region are similar to *A. yucatanus*. *Argulus chromidis* was described from a single female specimen, collected at Lake Nicaragua on the gills of a species of “*Chromis*,” which Gill (1903) pointed out was likely a species of cichlid, whereas *Argulus cubensis* was discovered in Cuba on the cichlid, *Cichlasoma tetracanthus* (Krøyer 1863, Wilson 1936b). Structures on the bases of the 4th legs of *A. yucatanus* and *A. kosus* Avenant-Oldewage, 1994 appear to be nearly identical, and males of both species also have a fleshy lobe between the coxae of the 4th legs. However, there are numerous differences, e.g.,

body shape, features of the first and 2nd maxillae, and secondary sexual structures on legs of males, to name a few, that distinguish these 2 species (Avenant-Oldewage 1994, Van As et al. 1999). The pair of pegs on the 3rd legs of male *A. yucatanus* resemble structures on males of other species, including *A. arcassonensis* Cuénot, 1912, *A. kusafugu* Yamaguti and Yamasu, 1959, and *A. kosus* (Yamaguti and Yamasu 1959, Masson and Delamare Deboutteville 1962, Van As et al. 1999).

The parasites of *Cichlasoma urophthalmus* have been studied by Salgado-Maldonado and Kennedy (1997), Moravec et al. (1998), and Vidal-Martinez et al. (1998). *Argulus yucatanus* serves as an intermediate host of the nematode, *Mexiconema cichlasomae*, whose definitive host is *C. urophthalmus* (Moravec et al. 1999) and was abundant on *C. urophthalmus* in Celestun Lagoon in 1994 (Moravec et al. 1998). Argulids were reported as a component of the diet of *C. urophthalmus* in Celestun Lagoon (Martinez-Palacios and Ross 1988). Celestun Lagoon is estuarine/marine with variable salinities throughout (Martinez-Palacios and Ross 1992, Herrera-Silveira 1994). The lagoon contains a mixture of estuarine and marine fish species, and *C. urophthalmus* inhabits freshwater as well as brackish to marine habitats (Salgado-Maldonado and Kennedy 1997). Vidal-Martinez et al. (1998) reported *Argulus mexicanus* from *C. urophthalmus* in freshwater; possibly their specimens were not *A. mexicanus*, but rather, *A. yucatanus*.

There are noteworthy points to make concerning *A. funduli*. Wilson (1902) and others have indicated incorrectly that the description of *A. funduli* was based on a female specimen, but that the specimen illustrated was a male. In the original description, the figure legends were given in both Danish (p. 97 [p. 23 of separate]) and Latin (p. 412 [p. 338 of separate]) with the former referring to a male and the latter to a female. This author agrees that Krøyer's figure depicts a male specimen (Krøyer 1863, his Plate 2, Figure 1a). In addition, the original description includes remarks about the length of the carapace of both the male and the female, and the single lot of specimens registered as types of *A. funduli* contains 6 specimens (collected in the vicinity of New Orleans, Louisiana, USA), including both sexes, in the same state of preservation and representing one species (ZMUC CRU-6473). Therefore, after reading a complete translation of the original description, no doubt exists that the description was based on more than one specimen (both male and female), and all 6 specimens are syntypes. After examining the types of *A. funduli* and comparing them with other descriptions, published illustrations, and other specimens, it became quite clear that the name *A. funduli* has been applied incorrectly to other

species. Some illustrations of *A. funduli* in Wilson (1902), Meehan (1940), Cressey (1972), Kabata (1988), and Overstreet et al. (1992) appear to represent species other than *A. funduli*. Results of an investigation into the taxonomy of *A. funduli* will be reported elsewhere.

ACKNOWLEDGMENTS

Special appreciation is expressed to F. Moravec (Institute of Parasitology, Academy of Sciences of the Czech Republic) for his generosity in providing the specimens of *A. yucatanus* for the description. W.G. Dyer (Southern Illinois University) facilitated some of the specimen loans and provided lab space and equipment. S. Schmitt and D. Gates (Southern Illinois University, Integrated Microscopy and Graphics Expertise) helped with specimen preparation, examination, and photography. J. Olesen (Zoologisk Museum), M. Siddall (AMNH), and A. Johnston (MCZ) loaned or cataloged specimens, and T.C. Walter (National Museum of Natural History) searched for the type of *A. rhamdiae*. M.E. Petersen (Zoologisk Museum) kindly translated Krøyer's original description of *A. funduli*, and V. Carrero checked the grammar of the Spanish abstract. Three anonymous reviewers provided helpful comments on the manuscript. This project was funded by a grant from the American Museum of Natural History's Lerner-Gray Fund for Marine Research and by the author.

LITERATURE CITED

- Avenant-Oldewage, A. 1994. A new species of *Argulus* from Kosi Bay, South Africa and distribution records of the genus. *Koedoe* 37:89–95.
- Avenant-Oldewage, A. and W.H. Oldewage. 1995. A new species of *Argulus* (Crustacea: Branchiura) from a bony fish in Algoa Bay, South Africa. *South African Journal of Zoology* 30:197–199.
- Bere, R. 1936. Parasitic copepods from Gulf of Mexico fish. *American Midland Naturalist* 17:577–625.
- Bouchet, G.C. 1985. Redescription of *Argulus varians* Bere, 1936 (Branchiura, Argulidae) including a description of its early development and first larval stage. *Crustaceana* 49:30–35.
- Cressey, R.F. 1972. The genus *Argulus* (Crustacea: Branchiura) of the United States. *Biota of Freshwater Ecosystems, U.S. Environmental Protection Agency Identification Manual 2*. U.S. Government Printing Office, Washington, DC, USA, viii + 14 p.
- Cunnington, W.A. 1931. Reports of an expedition to Brazil and Paraguay in 1926–27, supported by the Trustees of the Percy Sladen Memorial Fund and the Executive Committee of the Carnegie Trust for Scotland. Argulidae. *Journal of the Linnean Society of London, Zoology* 37(252):259–264, 2 pls.

- Fryer, G. 1959. A report on the parasitic Copepoda and Branchiura of the fishes of Lake Bangweulu (northern Rhodesia). *Proceedings of the Zoological Society of London* 132:517–550.
- Gill, T. 1903. The hosts of argulids and their nomenclature. *Science*, n. ser. 17:33.
- Herrera-Silveira, J.A. 1994. Spatial heterogeneity and seasonal patterns in a tropical coastal lagoon. *Journal of Coastal Research* 10:738–746.
- Kabata, Z. 1988. Copepoda and Branchiura. In: L. Margolis and Z. Kabata, eds. *Guide to the parasites of fishes of Canada, Part II, Crustacea*. Canadian Special Publication of Fisheries and Aquatic Sciences 101, Department of Fisheries and Oceans, Ottawa, Ontario, Canada, p. 3–127.
- Krøyer, H. 1863. Bidrig til kundskab om snyltekrebsene. *Naturhistorisk Tidsskrift* (raekke 3) 2:75–320, 9 pls. (continued, 321–426, 9 pls., 1864) [also published as a separate: Krøyer, H. 1863. *Bidrag til kundskab om snyltekrebsene*. Thieles Bogtrykkeri, Kjøbenhavn, 352 p., 18 pls.].
- Martinez-Palacios, C.A. and L.G. Ross. 1988. The feeding ecology of the Central American cichlid *Cichlasoma urophthalmus* (Gunther). *Journal of Fish Biology* 33:665–670.
- Martinez-Palacios, C.A. and L.G. Ross. 1992. The reproductive biology and growth of the Central American cichlid *Cichlasoma urophthalmus* (Günther). *Journal of Applied Ichthyology* 8:99–109.
- Masson, M. and C. Delamare Deboutteville. 1962. Études sur les crustacés branchiures d'Europe. II. Les caractères sexuels du mâle chez *Argulus giordanii* Brian et chez *A. arcassonensis* Cuénot. *Bulletin du Muséum National d'Histoire Naturelle* (2e Série) 34:387–396.
- Meehan, O.L. 1940. A review of the parasitic Crustacea of the genus *Argulus* in the collections of the United States National Museum. *Proceedings of the United States National Museum* 88(3087):459–522.
- Moravec, F., M.I. Jiménez-García and G. Salgado-Maldonado. 1998. New observations on *Mexiconema cichlasomae* (Nematoda: Dracunculoidea) from fishes in Mexico. *Parasite* 5:289–293.
- Moravec, F., V. Vidal-Martínez and L. Aguirre-Macedo. 1999. Branchiurids (*Argulus*) as intermediate hosts of the dani-conematid nematode *Mexiconema cichlasomae*. *Folia Parasitologica* 46:79.
- Overstreet, R.M., I. Dyková and W.E. Hawkins. 1992. Branchiura. In: F.W. Harrison and A.G. Humes, eds. *Microscopic Anatomy of the Invertebrates*, Vol. 9 Crustacea. Wiley-Liss, Inc., New York, NY, USA, p. 385–413.
- Pineda, R., S. Páramo and R. Del Río. 1995. A new species of the genus *Argulus* (Crustacea: Branchiura) parasitic on *Atractosteus tropicus* (Pisces: Lepisosteidae) from Tabasco, Mexico. *Systematic Parasitology* 30:199–206.
- Poly, W.J. 2003. *Argulus ambystoma*, a new species parasitic on the salamander *Ambystoma dumerilii* from México (Crustacea: Branchiura: Argulidae). *Ohio Journal of Science* 103:52–61.
- Rupp, M.B. 1990. An abbreviated method for preparing *Ixodes damini* ticks for scanning electron microscopy observation. *Journal of Electron Microscopy Technique* 15:99–100.
- Salgado-Maldonado, G. and C.R. Kennedy. 1997. Richness and similarity of helminth communities in the tropical cichlid fish *Cichlasoma urophthalmus* from the Yucatan Peninsula, Mexico. *Parasitology* 114:581–590.
- Van As, J.G., J.P. Van Niekerk, and P.A.S. Oliver. 1999. Description of the previously unknown male of *Argulus kosus* Avenant-Oldewage, 1994 (Crustacea: Branchiura). *Systematic Parasitology* 43:75–80.
- Vidal-Martínez, V.M., C.R. Kennedy, and M.L. Aguirre-Macedo. 1998. The structuring process of the macroparasite community of an experimental population of *Cichlasoma urophthalmus* through time. *Journal of Helminthology* 72:199–207.
- Wilson, C.B. 1902. North American parasitic copepods of the family Argulidae, with a bibliography of the group and a systematic review of all known species. *Proceedings of the United States National Museum* 25(1302):635–742, 23 figs., 2 pls.
- Wilson, C.B. 1936a. Copepods from the cenotes and caves of the Yucatan Peninsula, with notes on cladocerans. *Carnegie Institution of Washington, Publication No. 457:77–88*, 18 figs.
- Wilson, C.B. 1936b. Two new parasitic copepods from Cuban fish. *Memorias de la Sociedad Cubana de Historia Natural "Feliipe Poey"* 10:107–112.
- Yamaguti, S. and T. Yamasu. 1959. On two species of *Argulus* (Branchiura, Crustacea) from Japanese fishes. *Biological Journal of Okayama University* 5:167–175.