

THREE NEW SPECIES OF *COLOBOMATUS* (COPEPODA: PHILICHTHYIDAE) PARASITIC IN THE MANDIBULAR CANALS OF HAEMULID FISHES

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Abstract.—Three new species of *Colobomatus* are described from the mandibular canals of three genera of American haemulid fishes. These are the first species of *Colobomatus* reported from the Haemulidae and are the first described with abdominal processes in the female. Males of two of the new species are described. One of the species (*C. quadrifarius*) is restricted to the Eastern Pacific and the other two (*C. caribbei* and *C. belizensis*) to the western Atlantic. Data are presented to suggest that an optimum host size exists for parasite infestation, accompanied by diminishing infestations in smaller and larger size groups.

During an examination of fishes in Belize for a study of host-parasite relationships, a new copepod belonging to the genus *Colobomatus* was discovered in the mandibular canals of its host fish, *Haemulon sciurus* (Shaw). Subsequent examination of 475 tropical and subtropical haemulid fishes (three genera and 32 species) yielded two additional new species from the same site on the hosts. Twenty of the 32 fish species examined were infested with one of the three new species.

Since Hesse's designation of the genus in 1873, 34 species of *Colobomatus* have been reported. They are members of the poecilostomatoid family Philichthyidae and are known only from the mucous and sensory canal systems of marine fishes. The females are typically highly modified with a variety of appendages and processes thought to be useful in maintaining position in the lateral-line canals (Izawa 1974). The males are much less modified and are smaller. Males of only nine species have been described thus far.

Sekerak (1970) published the first report of *Colobomatus* found in the "dentary canals" of host fish. Essafi and Raibaut (1980) described a closely related genus *Colobomatoides* from the pre-opercular cephalic system. All of the copepods in the present study were located in the mandibular canals of the hosts.

Methods and Materials

Fresh and alcohol-preserved fish were examined by removing the skin of the ventral portions of the lower jaws and exposing the mandibular canals. Figure 1 shows the typical position of the parasite in one of the chambers of the canal. In total, 238 copepods were recovered, 181 ♀ and 1 ♂ of *Colobomatus belizensis*, 47 ♀ and 2 ♂ of *C. quadrifarius* and 7 ♀ of *C. caribbei*. Numbers preceding host names in Materials Examined sections indicate the number of infested fish. Table 2 indicates numbers of fish examined. The abbreviation USNM refers to Smithsonian Institution and SOSOC to Smithsonian Oceanographic Sorting Center specimens now in the general collections of the Division of Fishes, Smithsonian Institution. Drawings were prepared with the aid of a Wild M20 compound microscope with drawing tube.

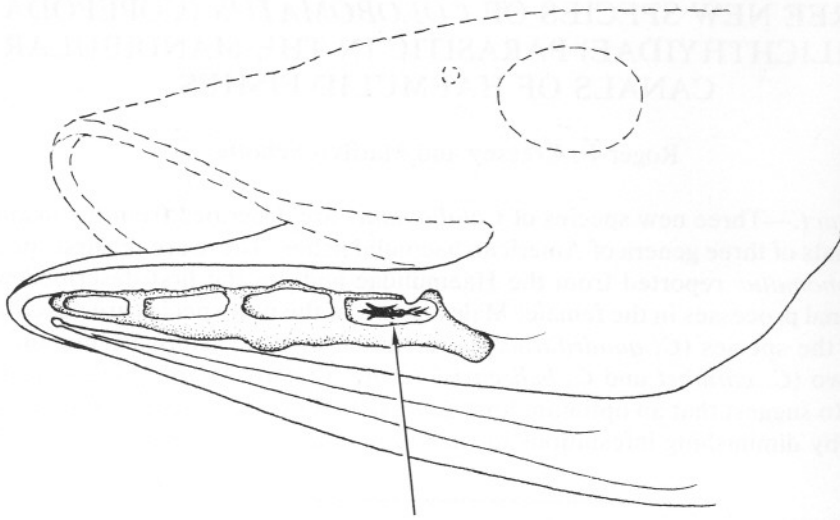


Fig. 1. Ventrolateral view of *Haemulon* mandibular canal showing position of *Colobomatus* *in situ*.

Colobomatus quadrifarius, new species
Figs. 2C-4E

Material examined.—Holotype ♀ (USNM 190517), allotype ♂ (USNM 190518), paratypes 15 ♀ (USNM 190519-22) from the mandibular canals of 17 *Orthopristis reddingi* Jordan and Richardson (USNM 43247, 167149, 167570 and 176154) from Baja California and Bay of Guaymas, Mexico. Additional material.—4 ♀ from 3 *Anisotremus davidsoni* (Steindachner) (USNM acc. no. 294075 and SOSC Ref. nos. 290 and 586) from Sonora, Mexico; 7 ♀ from 5 *A. dovii* (Gunter) (USNM 144347-8 and USNM acc. no. 294075) from Colombia and Panama (both Pacific); 6 ♀ from 3 *A. interruptus* (Gill) (USNM 181330) from Nayarit, Mexico; 3 ♀ and 1 ♂ from 2 *A. pacifici* (Gunter) (USNM 114476, 220731) from El Salvador and Guatemala; 5 ♀ from 4 *Haemulon flaviguttatum* Gill (USNM 50426, 80548, 176149) from Panama and Baja California; 4 ♀ from 3 *H. steindachneri* (Jordan and Gilbert) (USNM 19632, 19879) from Colima and Cape St. Lucas, Mexico; 2 ♀ from 1 *Orthopristis chalceus* (Gunter) (USNM 41389) from Galapagos.

Description.—Female: Body form as in Fig. 2C. Length of body: 4.73-7.58 mm based on 3 specimens. Pre-oral cephalic process bifurcate. Body constricted be-

Table 1.—Rate of infestation by *Colobomatus belizensis* in mandibular canals of 91 specimens of *Haemulon sciurus* related to size of fish.

Host SL (mm)	<80	80-109	110-139	140-169	170-199	200-229	>230
Negative fish	13	7	2	0	2	2	1
One <i>Colobomatus</i>	2	5	2	2	7	3	—
Two <i>Colobomatus</i>	1	1	10	12	15	3	—
Three <i>Colobomatus</i>	0	0	0	1	0	0	—
% Infestation	19%	46%	86%	100%	92%	75%	—

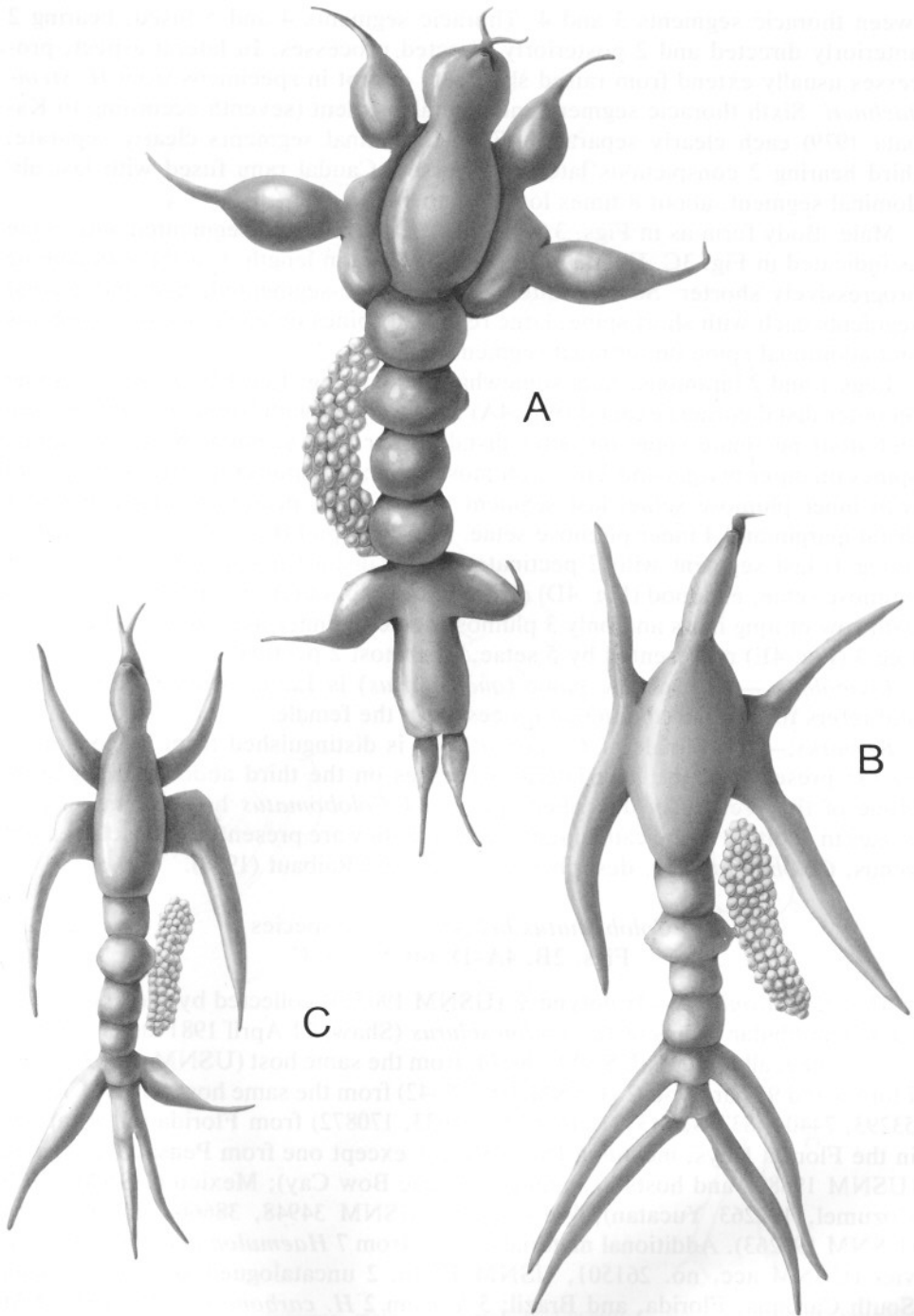


Fig. 2. A, *Colobomatus caribbi*, female, ventral; B, *C. belizensis*, female, ventral; C, *C. quadrifarius*, female, ventral.

tween thoracic segments 3 and 4. Thoracic segments 4 and 5 fused, bearing 2 anteriorly directed and 2 posteriorly directed processes. In lateral aspect, processes usually extend from raised shoulders except in specimens from *H. steindachneri*. Sixth thoracic segment and genital segment (seventh according to Kabata 1979) each clearly separated. Four abdominal segments clearly separate, third bearing 2 conspicuous lateral processes. Caudal rami fused with last abdominal segment, about 8 times longer than wide.

Male: Body form as in Figs. 3A and 3B. First antenna 6-segmented with setae as indicated in Fig. 3C. First 3 segments subequal in length, last three becoming progressively shorter. Second antenna (Fig. 3D) 5-segmented, first and second segments each with short spine, large recurved spines on each of last 3 segments and additional spine on terminal segment.

Legs 1 and 2 biramous; rami somewhat overlapping. Leg 1 basipod with spine on outer distal corner; exopod (Fig. 4A) first segment with fringe on outer margin and stout pectinate spine on outer distal corner, last segment with 4 pectinate spines on outer margin and 3 inner plumose setae; endopod (Fig. 4B) first segment with inner plumose setae, last segment with 2 stout pectinate spines on outer distal margin and 4 inner plumose setae. Leg 2 exopod (Fig. 4C) first segment as in leg 1, last segment with 2 pectinate spines, distal fringed spine, and 2 inner plumose setae; endopod (Fig. 4D) as in leg 1 except outer margin of first segment with row of long hairs and only 3 plumose setae on inner margin of last segment. Leg 3 (Fig. 4E) represented by 5 setae, innermost 2 pectinate.

Etymology.—The specific name (*quadrifarius*) is Latin meaning "four-fold" and refers to the four abdominal processes in the female.

Remarks.—The female of *C. quadrifarius* is distinguished from its congeners by the presence of the long lateral processes on the third abdominal segment. None of the previously described species of *Colobomatus* has abdominal processes in addition to the caudal rami, although they are present in a closely related genus, *Colobomatoides*, described by Essafi and Raibaut (1980).

Colobomatus belizensis, new species

Figs. 2B, 4A–D, 6B–E, 7A–C

Material examined.—Holotype ♀ (USNM 190523) collected by the first author from mandibular canals of *Haemulon sciurus* (Shaw) 21 April 1981 at Carrie Bow Cay, Belize; allotype ♂ (USNM 190524) from the same host (USNM 167633) from Florida and 91 paratype ♀ (USNM 190525–42) from the same host (USNM 15815, 53293, 74404, 83798, 143731, 167610, 167633, 170872) from Florida (all locations in the Florida Keys, including Dry Tortugas except one from Pensacola); Belize (USNM 198808 and hosts examined at Carrie Bow Cay); Mexico (USNM 37089 Cozumel, 192263 Yucatan); West Indies (USNM 34948, 38666, 38739); Cuba (USNM 192263). Additional material.—12 ♀ from 7 *Haemulon aurolineatum* Cuvier (USNM acc. no. 261501, USNM 17716, 2 uncatalogued specimens) from South Carolina, Florida, and Brazil; 5 ♀ from 2 *H. carbonarium* Poey (USNM 80586, USNM acc. no. 249542) from Dominica and Panama; 15 ♀ from 8 *H. chrysarygyreum* Günther (USNM 6940, 35149–50, 35093, 41314) from Key West, Barbados, Abaco, and St. Lucia; 1 ♀ from 1 *H. macrostomum* Günther (USNM 80589) from Panama; 6 ♀ from 4 *H. melanurum* (Linnaeus) (USNM 3118, 10511,

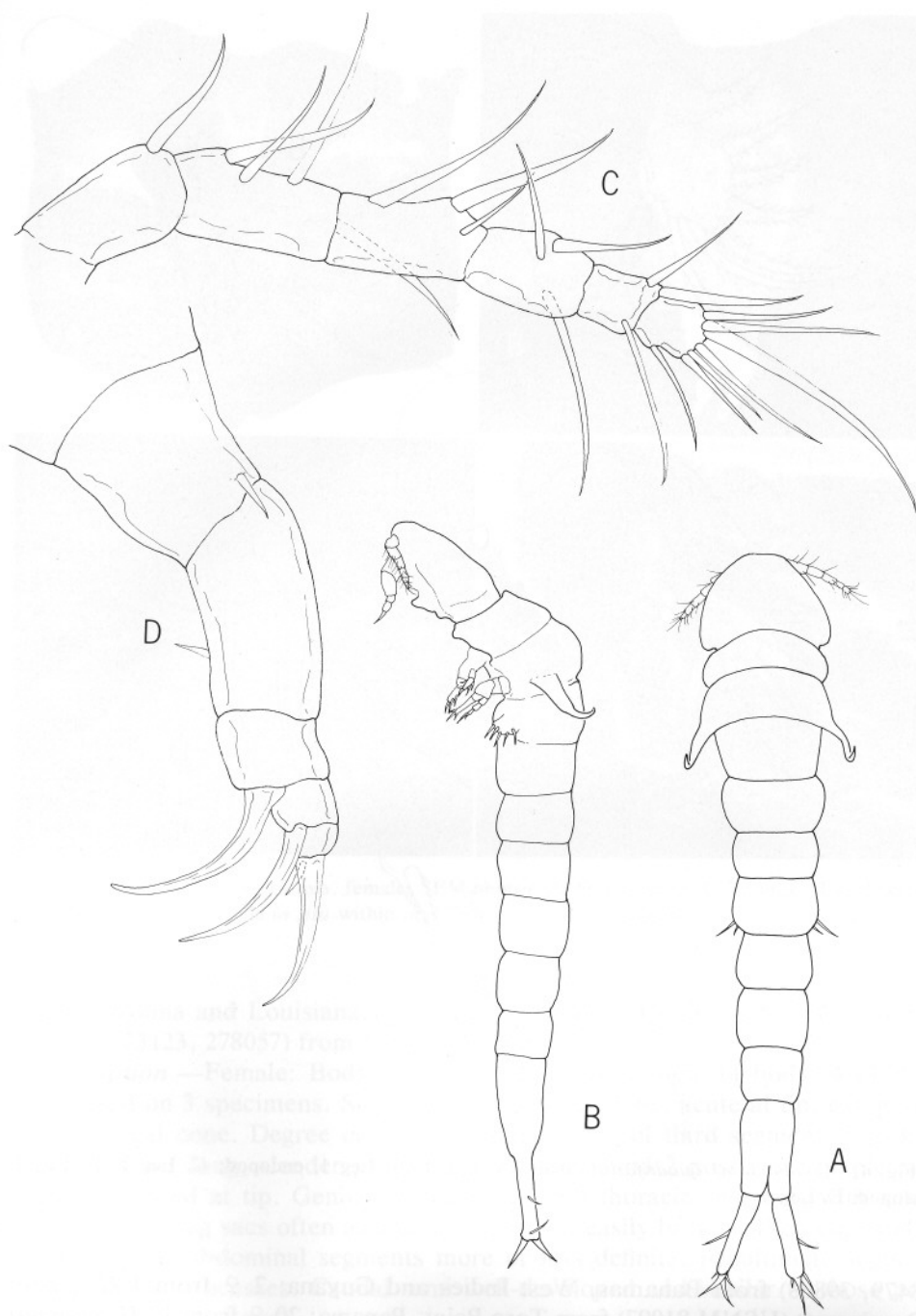


Fig. 3. *Colobomatus quadrifarius*, male: A, Dorsal; B, Lateral; C, First antenna; D, Second antenna.

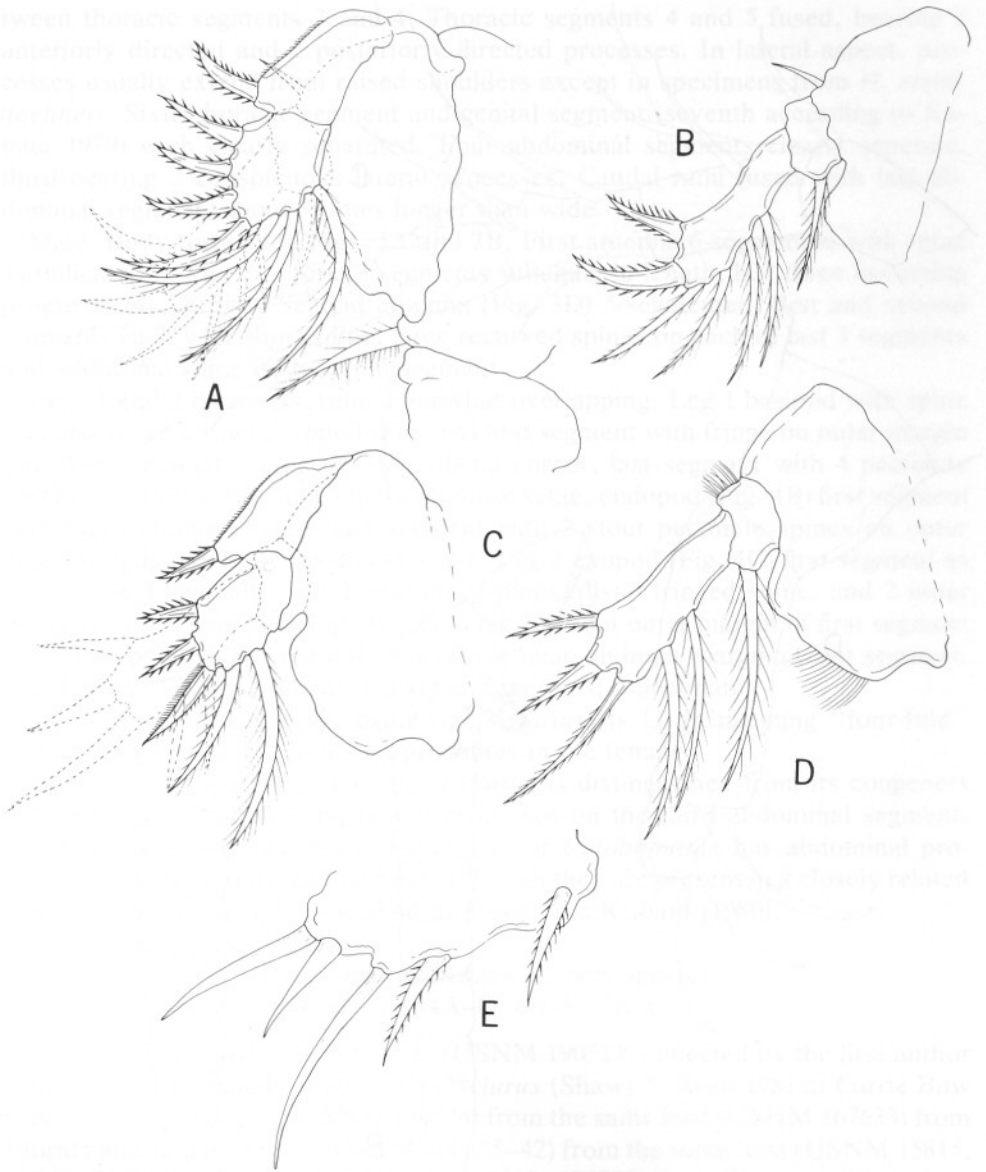


Fig. 4. *Colobomatus quadrifarius*, male: A, Leg 1; B, Leg 1, endopod; C, Leg 2; D, Leg 2, endopod; E, Leg 3.

38479, 39808) from Bahamas, West Indies and Guyana; 2 ♀ from 1 *H. parrai* (Desmarest) (USNM 81097) from Toro Point, Panama; 20 ♀ from 12 *H. plumieri* (Lacépède) (USNM 37088, 82448, 142536, acc. no. 294075) from Cuba, Virgin Islands, Colombia (Caribbean) and Cozumel, Mexico; 16 ♀ from 10 *H. steindachneri* (Jordan and Gilbert) (USNM 10265, acc. no. 278057, Oregon stations 5654, 10536, 17628-9) from Caribbean coast of South America (Colombia to Brazil); 9 ♀ from 9 *Orthopristis chrysopterus* (Linnaeus) (USNM 35205, 163701)

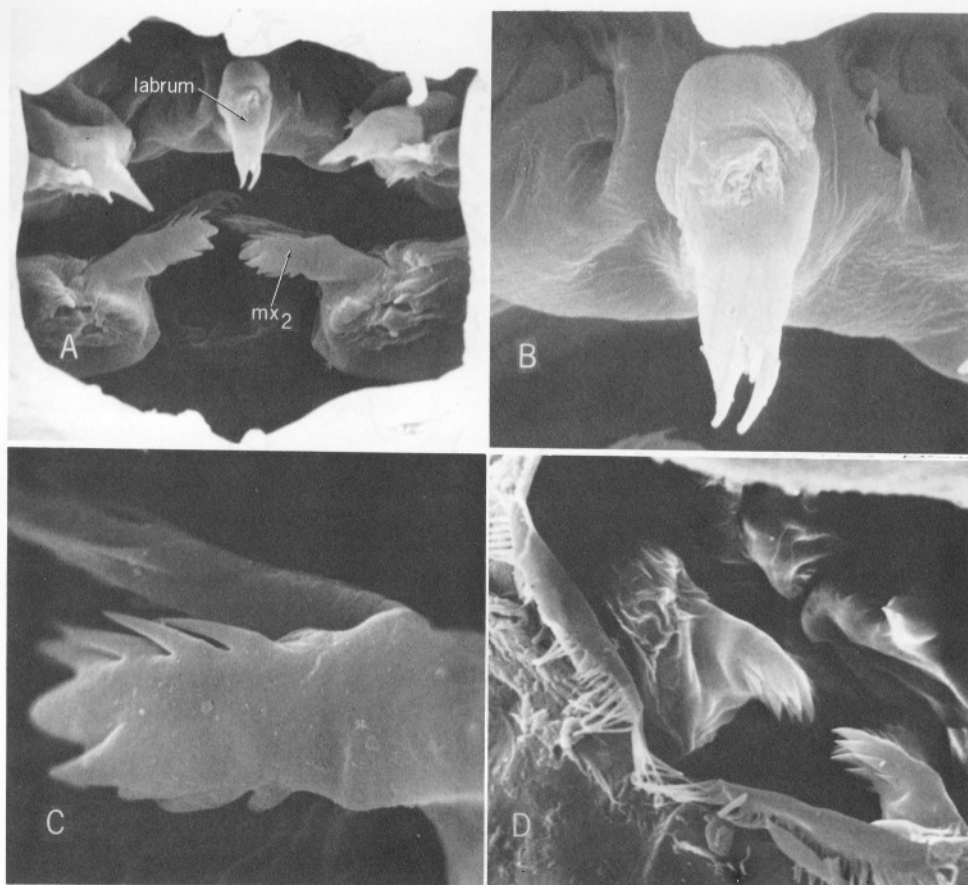


Fig. 5. *Colobomatus belizensis*, female, SEM photos: A, Oral area; B, Labrum; C, Tip of second maxilla; D, Second maxilla *in situ* within oral cone (lower fringe-labium?).

North Carolina and Louisiana; 3 ♀ from 2 *O. ruber* (Cuvier and Valenciennes) (USNM 123123, 278057) from Venezuela and Guyana.

Description.—Female: Body form as in Fig. 2B. Length of body: 4.13–9.38 mm, based on 3 specimens. Single, simple cephalic lobe, acute at tip, extending above buccal cone. Degree of segmentation at base of third segment (“neck”) variable. Four long, slender processes, 2 anterior and 2 posterior, simple and usually rounded at tip. Genital segment (seventh thoracic segment) with small lateral lobes. Egg sacs often as long as abdomen, easily broken when copepod is handled. Four abdominal segments more or less definite; penultimate segment with 2 lateral processes. Caudal rami well-developed and similar to those processes described above.

First antenna very small, placed dorsolaterally near insertion of buccal cone. Oral area typical of genus (see SEM photos, Figs. 5A–D). Labrum modified as forked, posteriorly directed process between mandibles. Mandibles with small ventral process; first maxilla bifid. Second maxilla considerably larger, bifid, terminal segments with numerous large spinose processes. Maxillipeds absent.

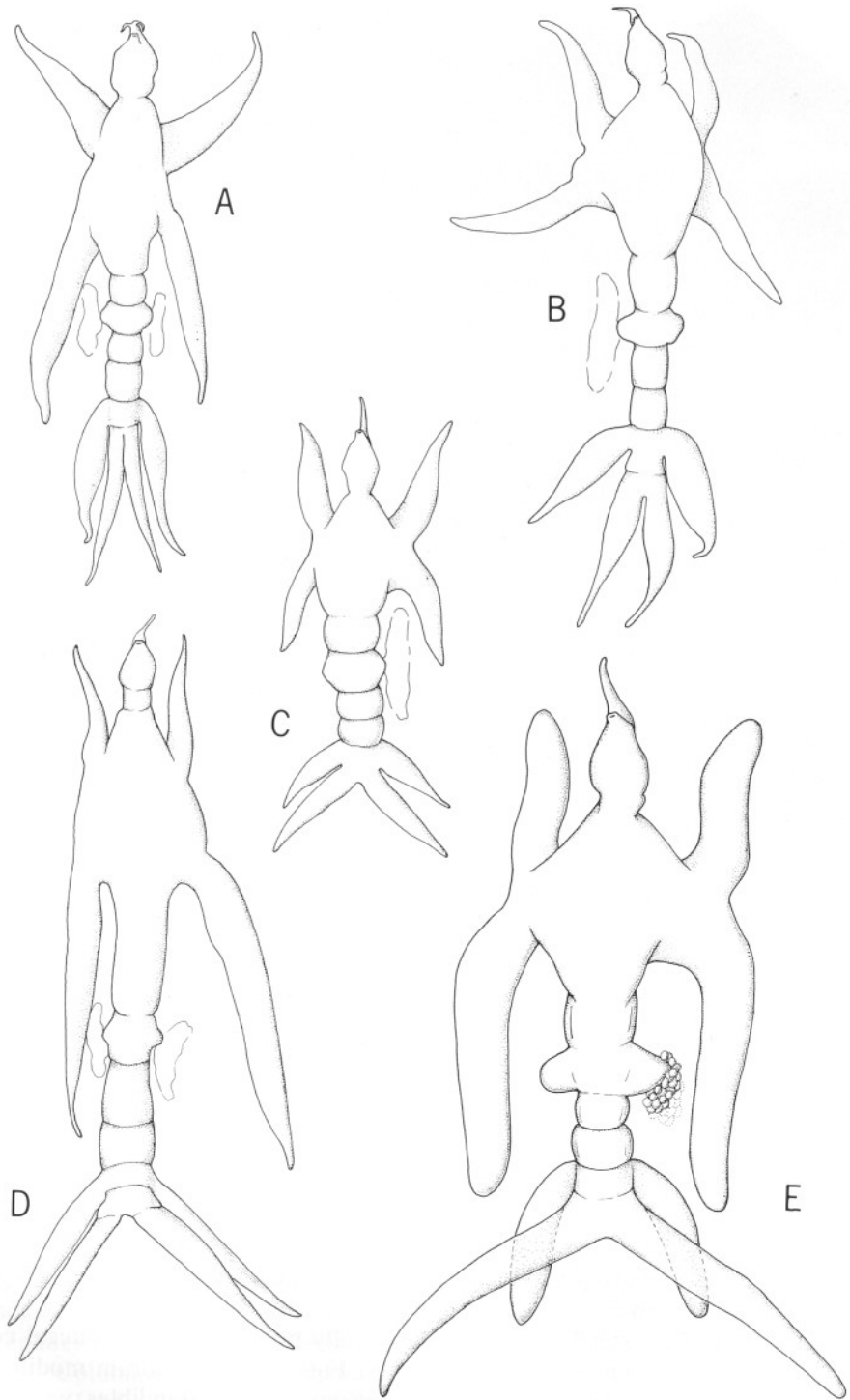


Fig. 6. *Colobomatus quadrifarius*, female: A, ventral; *C. belizensis*: B-E, Ventral.

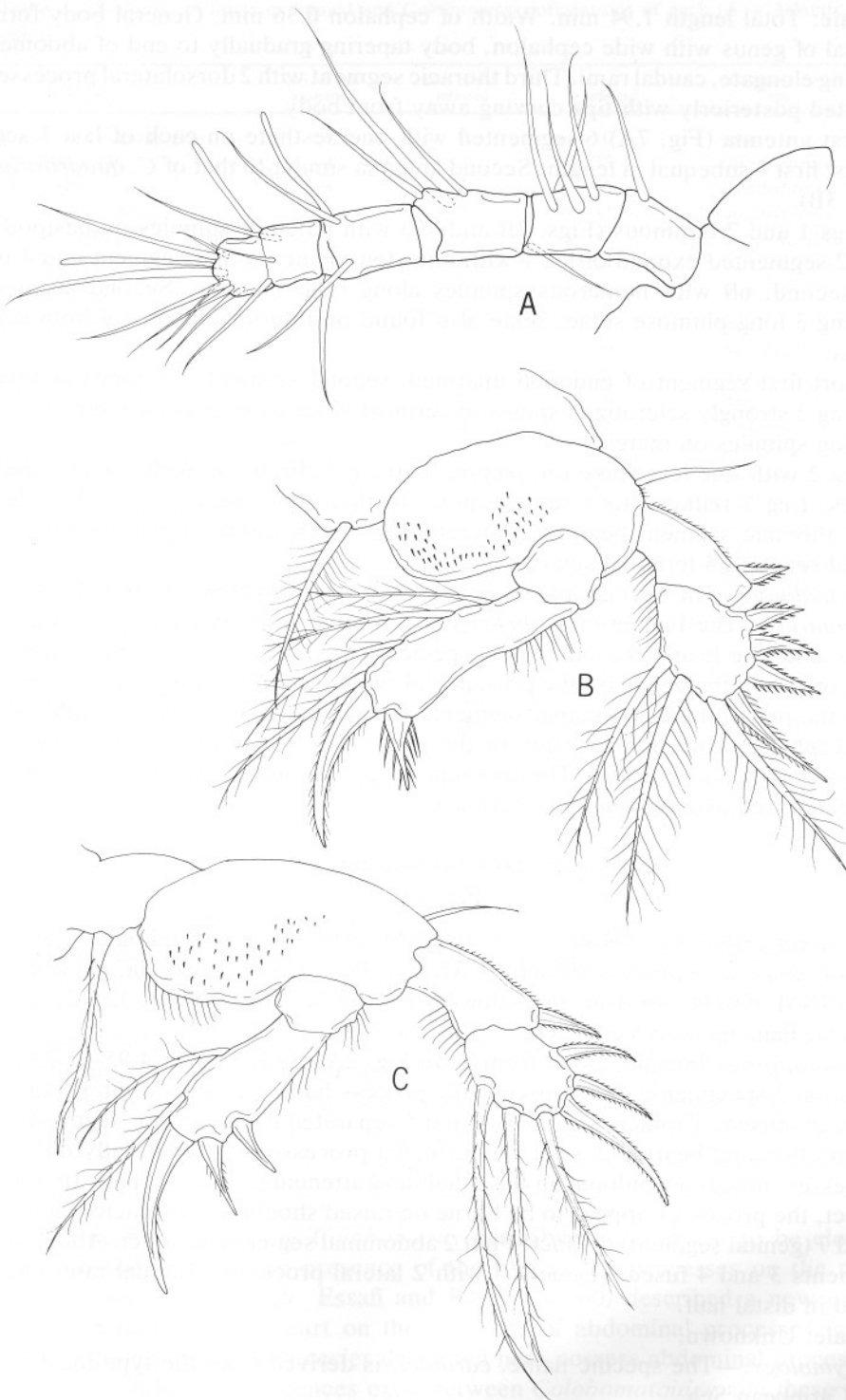


Fig. 7. *Colobomatus belizensis*, male: A, First antenna; B, Leg 1; C, Leg 2.

Male: Total length 1.94 mm. Width of cephalon 0.36 mm. General body form typical of genus with wide cephalon, body tapering gradually to end of abdomen bearing elongate, caudal rami. Third thoracic segment with 2 dorsolateral processes directed posteriorly with tips curving away from body.

First antenna (Fig. 7A) 6-segmented with one aesthete on each of last 3 segments; first 4 subequal in length. Second antenna similar to that of *C. quadrifarius* (Fig. 3B).

Legs 1 and 2 biramous (Figs. 7B and 7C) with patch of spinules on basipods. The 2-segmented exopod of leg 1 with one stout spine on first segment and 4 on the second, all with numerous spinules along both margins. Second segment bearing 3 long plumose setae; setae also found on interior margins of both segments.

Short first segment of endopod unarmed; second segment, 2.5 times as long, bearing 2 strongly sclerotized spines, innermost twice as long as outermost, each bearing spinules on margins.

Leg 2 with one less spine on exopod than leg 1. Endopod with 2 setae and 3 spines. Leg 3 reduced to 5 setae, similar to that of *C. quadrifarius* (Fig. 4E). Fifth thoracic segment bearing 2 lateral setae. Each caudal ramus bearing one lateral seta and 4 terminal setae.

Etymology.—The specific name, *belizensis*, is derived from the type-locality.

Remarks.—The female of *C. belizensis* is similar in body form to *C. quadrifarius* and like it and the other new species, *C. caribbei*, can be differentiated from others in the genus by the presence of two long lateral processes extending from the penultimate abdominal segment. The present species has a single, simple, cephalic projection anterior to the oral cone in contrast to the bifurcate process of *C. quadrifarius*. The thoracic processes appear to be more dorsally placed as well as raised in *C. quadrifarius*.

Colobomatus caribbei, new species

Fig. 2A

Material examined.—Holotype ♀ (USNM 190543) from mandibular canal of *Anisotremus surinamensis* (Bloch) (USNM 123121) from Venezuela, paratypes 6 ♀ (USNM 190544–46) from the same host (USNM 30878, 80533, 123121) from Florida, Panama, and Venezuela.

Description.—Female: Body form as in Fig. 2A. Body length: 4.95–12.23 mm based on 5 specimens. Anterior cephalic process bifid. Head and first 3 thoracic segments fused. Thoracic segments 4 and 5 separated from anterior segments by constriction and bearing 2 anteriorly directed processes and 2 laterally directed processes; processes bulbous in basal half and attenuated in distal half. In dorsal aspect, the processes appear to be borne on raised shoulders. Thoracic segments 6 and 7 (genital segment) distinct. First 2 abdominal segments distinct. Abdominal segments 3 and 4 fused; segment 3 with 2 lateral processes. Caudal rami attenuated in distal half.

Male: Unknown.

Etymology.—The specific name, *caribbei*, is derived from the type-locality in the Caribbean Sea.

Remarks.—As in the two previous species, this species is characterized by the

Table 2.—Synopsis of hosts examined and *Colobomatus* infestations of each (A = Atlantic, P = Pacific).

Fish species	No. of fish examined	No. of fish infested	% infested	<i>Colobomatus</i> spp.
<i>Anisotremus caesius</i> (P)	4	0	0	neg
<i>A. davidsoni</i> (P)	4	3	75	<i>quadrifarius</i>
<i>A. dovii</i> (P)	8	5	60	<i>quadrifarius</i>
<i>A. interruptus</i> (P)	10	3	33	<i>quadrifarius</i>
<i>A. pacifici</i> (P)	12	2	17	<i>quadrifarius</i>
<i>A. surinamensis</i> (A)	9	4	44	<i>caribbei</i>
<i>A. virginicus</i> (A)	15	0	0	neg
<i>Haemulon album</i> (A)	11	0	0	neg
<i>H. aurolineatum</i> (A)	14	7	50	<i>belizensis</i>
<i>H. bonariense</i> (A)	17	0	0	neg
<i>H. boschmae</i> (A)	26	0	0	neg
<i>H. carbonarium</i> (A)	13	2	15	<i>belizensis</i>
<i>H. chrysargyreum</i> (A)	9	8	89	<i>belizensis</i>
<i>H. flaviguttatum</i> (P)	13	4	31	<i>quadrifarius</i>
<i>H. flavolineatum</i> (A)	15	0	0	neg
<i>H. macrostomum</i> (A)	13	1	8	<i>belizensis</i>
<i>H. maculicauda</i> (P)	16	0	0	neg
<i>H. melanurum</i> (A)	10	4	40	<i>belizensis</i>
<i>H. parrai</i> (A)	13	1	8	<i>belizensis</i>
<i>H. plumieri</i> (A)	13	12	92	<i>belizensis</i>
<i>H. sciurus</i> (A)	91	64	70	<i>belizensis</i>
<i>H. scudderi</i> (P)	14	0	0	neg
<i>H. sexfasciatum</i> (P)	10	0	0	neg
<i>H. steindachneri</i> (A)	21	10	45	<i>belizensis</i>
<i>H. steindachneri</i> (P)	16	3	19	<i>quadrifarius</i>
<i>H. striatum</i> (A)	16	0	0	neg
<i>Orthopristis brevipinnis</i> (P)	3	0	0	neg
<i>O. chalceus</i> (P)	12	1	8	<i>quadrifarius</i>
<i>O. chrysopterus</i> (A)	6	5	83	<i>belizensis</i>
<i>O. forbesi</i> (P)	2	0	0	neg
<i>O. reddingi</i> (P)	30	17	56	<i>quadrifarius</i>
<i>O. ruber</i> (A)	9	2	22	<i>belizensis</i>

presence of lateral processes on the penultimate segment. The bifid cephalic lobe distinguishes the present species from *C. belizensis*, and the bulbous nature of the appendages as well as the fused abdominal segments separate it from *C. quadrifarius* and *C. belizensis*.

Discussion

The three new species of *Colobomatus* described here appear to be closely related on the basis of the presence of the two lateral processes on the third abdominal segment of each. Essafi and Raibaut (1980) described a new genus *Colobomatoides* based in part on the presence of abdominal processes in the female. Although the three species described here possess abdominal processes, we feel that sufficient differences exist between *Colobomatoides* and these new species to warrant including the three new ones in the genus *Colobomatus*. These

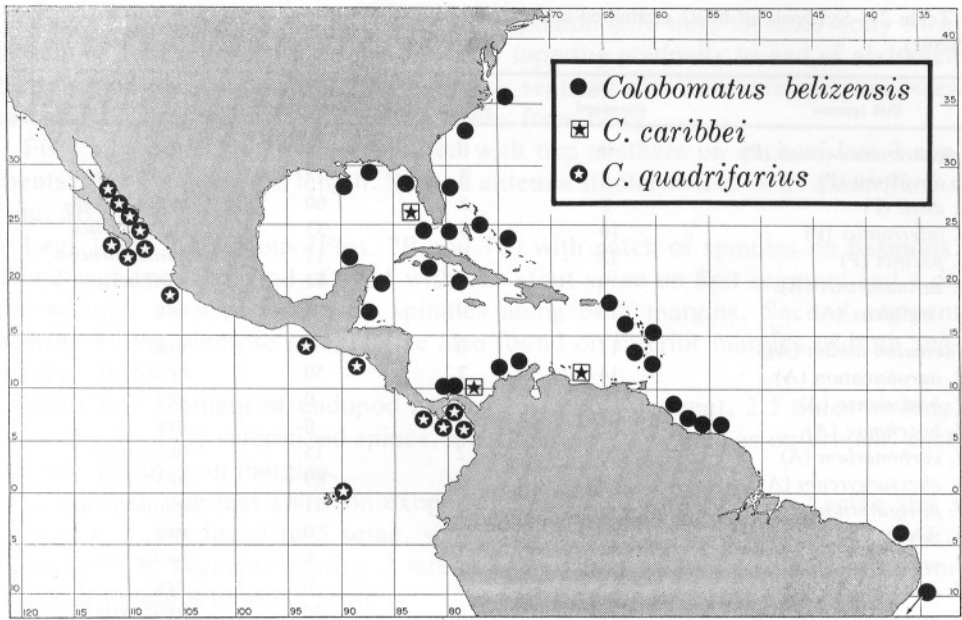


Fig. 8. Distribution of three new species of *Colobomatus*.

new species, however, are the first *Colobomatus* species with this character to be described.

The generic diagnosis of *Colobomatus* should be amended to state that the female may or may not possess abdominal processes and the key to philichthyid genera provided by Essafi and Raibaut (1980) modified.

Effect of Host Size

Table 1 suggests that an optimum size host is preferred by the parasite. All 15 specimens of *Haemulon sciurus* between 140–169 mm SL were infested. The rate of infestation diminishes in smaller and larger size groups.

Host Specificity and Biogeography

The present work includes species of hosts from three haemulid genera present in the tropical and semitropical western Atlantic and eastern Pacific (see Table 2). Figure 8 shows the distribution of each of the species. *Colobomatus quadrifarius* infests species of three genera (*Haemulon*, *Orthopristis*, and *Anisotremus*) in the eastern Pacific with little host specificity indicated beyond a possible restriction to haemulid fishes. The two Atlantic *Colobomatus* species, however, do show some degree of host specificity as *C. caribbei* is known thus far only from *Anisotremus*, and *C. belizensis* from *Haemulon* and *Orthopristis*.

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