FIRST RECORDS OF POLYCHAETOUS ANNELIDS FROM CENOTE AEROLITO (SINKHOLE AND ANCHIALINE CAVE) IN COZUMEL ISLAND, MEXICO

SARITA C. FRONTANA-URIBE AND VIVIANNE SOLIS-WIESS

Abstract: In this study, polychaetous annelids are recorded for the first time in Mexican cenotes and anchialine caves. These organisms were collected in the Cenote Aerolito (Cozumel Island, on the Caribbean coast of Quintana Roo) during three sampling events from February 2006 to April 2008, among algae, roots of mangroves, and in karst sediments. A total of 1518 specimens belonging to five families (Paraonidae, Capitellidae, Nereididae, Dorvilleidae, and Syllidae), ten genera, and eleven species were collected. In the cave system, two specimens of the amphipod Hermodice carunculata were found. This cenote and its biota are now in danger of disappearing because of a marina construction project in its western shore.

INTRODUCTION

Polychaetes constitute the largest class of the phylum Annelida, with about 12,000 species described to date in more than 80 recognized families (Rouse and Pleijel, 2006). They are ubiquitous in marine habitats from intertidal to abyssal depths, where they are often the most diverse or dominant group. However, they are also found in some freshwater habitats and in karst systems like cenotes (or sinkholes) and even in the associated caves. Cave records are scarce, but the most important can be found in Augener, 1932; Remy, 1937; Hartmann-Schröder, 1977 and 1986; Sket and Iliffe, 1980; Culver and Sket, 2000; Wilson and Humphreys, 2001; and Martinez-García et al., 2009.

In 2002, Schmitter-Soto et al. made an exhaustive list of organisms collected in Yucatan cenotes, from bacteria and protozoa to algae and small invertebrates, such as copepods, amphipods, and isopods, but these authors did not report polychaetes; larger animals, such as fishes, amphibia, iguanas or crocodiles are better known in these habitats. Previously, Suárez-Morales and Rivera-Arriaga (1998) mentioned that no published references exist about free living nematodes, annelids, or mollusks in the Yucatán cenotes. Mejía-Ortiz et al. (2007b) studied some of the cenotes’ macrofauna of Cozumel Island and mentioned the presence of worms in the cave system of Cenote Aerolito, but they did not specify if they were indeed polychaetes. In this study, we focused solely on the polychaetous annelids in this cenote and its cave system.

Cenotes are sinkholes found almost everywhere in the Yucatán Peninsula, in the northern Mexican Caribbean, about 18 km from the mainland (Pacheco and Vega, 2008). Its soil is mainly karstic, composed of limestone (Wurl and Giese, 2005), with four kinds of cenotes represented: those with surface connection narrower than the diameter of the water body (cenotes cármen), those with vertical walls (cenotes cilíndricos), those degraded to shallow water basins (cenotes aguadas), and those with horizontal entrances to dry sections (grutas). The island’s freshwater supply comes mainly from the cenotes and associated subterranean water systems (Mejía-Ortiz et al., 2007b). It has approximately 70,000 inhabitants and is totally devoted to tourism, which nowadays is expanding at a rate of more than 100% per year (Solís-Weiss et al., 2007).

Cenote Aerolito, one of the 18 cenotes known in Cozumel Island, is located close to the western coast of Cozumel, at 240 m from shore (20°28’00” N and 86°58’45” W). It is approximately 68 m long, 25 m wide, and 8 m deep. It is connected to the sea through an underwater cave system (Mejía-Ortiz et al., 2007a). At its northwestern end,
a relict of mangrove vegetation is present (*Rhizophora mangle* Linnaeus, 1753) (Fig. 1), and large aggregations of algae are found all around its edges.

**METHODS**

Samples were collected by hand in February 2006 as part of the project Echinoderms from Cozumel Anchialine Caves. Each sample consisted of 200 ml of algae or karst sediment taken among mangrove roots in an area close to the main cave entrance of the Cenote Aerolito (station 1-06). In June 2007, as part of the project Benthic Fauna of the Mexican Caribbean Shores, further sampling was carried out at four stations (1-07, 2-07, 3-07, and 4-07); approximately 1000 ml of algae were collected, as well as karst sediment along the eastern edge of the cenote. A third sampling occurred in April 2008 at five stations (1-08, 2-08, 3-08, 4-08, and 5-08), and an additional station (6-08) was sampled using scuba diving in its cave system (Fig. 1, Table 1). Physical and chemical parameters were measured during each visit with a Hydrolab Data Sonde (HDS3) multiparameter probe.
All the biological material was fixed in 7% formalin in the field, later rinsed with water, sieved through a 0.5 mm sieve, preserved in 70% alcohol, and identified to species level. The taxonomic arrangement follows Rouse and Fauchald (1997). In the faunal list, the syllids listed as sp. 1 are incomplete specimens, so their identification could only be carried out to the genus level. The dorvilleids identified as *Ophryotrocha* sp. A could not be referred to a known species and are now under study as potentially new to science. All the specimens are deposited in the National Polychaete Collection of the Laboratorio de Ecología y Biodiversidad de Invertebrados Marinos, Instituto de Ciencias del Mar y Limnología, UNAM (CPICML-UNAM, DFE.IN.061.0598).

The sediment was classified following Folk’s (1974) method for size classes, while mineralogical and organic composition was done with the method of Gaudette et al. (1974).

**RESULTS**

A total of 1518 specimens belonging to five families (Paraoonidae, Capitellidae, Nereididae, Dorvilleidae, and Syllidae), ten genera, and eleven species are reported for Cenote Aerolito, while in its cave system two specimens of *Hermodice carunculata* were found. All the polychaete species collected during this study represent first records for the location in which they were found.

**SPECIES ACCOUNT**

Capitellidae Grube, 1862

*Capitella* cf. *capitata* (Fabricius, 1780) species complex


Description. Largest specimen complete with 36 chaetigers, 11-mm long and 0.9-mm wide including parapodia, smaller specimen complete with 12 chaetigers, 5-mm long and 0.5-mm wide including parapodia. Prostomium broad and triangular; eyes absent. Body elongate, thoracic region broadest, partially inflated, with narrow segments; thoracic chaetigers with reduced podial lobes and capillary chaetae in both rami from chaetigers 1–6; chaetiger 7 with capillaries or mixed fascicles of capillary and hooded hooks; parapodia of chaetigers 8–9 with only hooks and, in most of the specimens, with enlarged opposing notopodial genital spines. Abdominal region narrower and segments longer with tori of hooded hooks. Pygidium without appendixes.

Habitat. In intertidal and subtidal mud and sand, especially in organically enriched sediments (Blake, 2000), dead coral (Ochoa-Rivera et al., 2000).

Distribution remarks. The species *C. capitata* has been considered cosmopolitan but is composed by several sibling species found to be genetically distinct, but morphologically similar (Grassle and Grassle, 1976; Grassle, 1980). Following the recent publication by Blake (2009) on this subject, we believe, as he does, that the true *C. capitata* will ultimately be confined to arctic and sub-arctic environments and that all other records of the species will ultimately be recognized as different species, some of them new to science. His important study of the taxonomic problems surrounding the so-called *C. capitata* complex will result in further studies of these species, so that, in this case, the species previously reported from Cozumel Island by Ochoa-Rivera et al. (2000) as *C. capitata* will probably have to be corrected, and that record, as well as the present one from Cenote Aerolito, will have to be re-evaluated.

*Capitella aciculatus* (Hartman, 1959)

Material examined. Cenote Aerolito, Cozumel Island, Quintana Roo, April 19, 2008 (2 specimens) in karst sediments (CPICML-UNAM-PO-17-034).

### Table 1. Sampling stations at Cenote Aerolito.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Latitude (N)</th>
<th>Longitude (W)</th>
<th>Depth (m)</th>
<th>Salinity (ppt)</th>
<th>Water Temp. (°C)</th>
<th>pH</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-06a</td>
<td>20°27’56.43”</td>
<td>86°58’41.43”</td>
<td>0.5</td>
<td>18.1</td>
<td>25.08</td>
<td>7.25</td>
<td>algae and sediment</td>
</tr>
<tr>
<td>1-07b</td>
<td>20°27’56.21”</td>
<td>86°58’42.21”</td>
<td>0.3</td>
<td>15.1</td>
<td>27.02</td>
<td>7.30</td>
<td>algae and sediment</td>
</tr>
<tr>
<td>2-07b</td>
<td>20°27’57.45”</td>
<td>86°58’41.55”</td>
<td>0.5</td>
<td>15.8</td>
<td>27.08</td>
<td>7.42</td>
<td>algae</td>
</tr>
<tr>
<td>3-07b</td>
<td>20°27’58.27”</td>
<td>86°58’41.27”</td>
<td>0.5</td>
<td>15.8</td>
<td>27.04</td>
<td>7.37</td>
<td>algae</td>
</tr>
<tr>
<td>4-07b</td>
<td>20°27’58.54”</td>
<td>86°58’41.54”</td>
<td>0.5</td>
<td>15.8</td>
<td>26.89</td>
<td>4.44</td>
<td>algae</td>
</tr>
<tr>
<td>1-08a</td>
<td>20°27’58.70”</td>
<td>86°58’41.20”</td>
<td>1.0</td>
<td>19.68</td>
<td>24.67</td>
<td>7.35</td>
<td>algae</td>
</tr>
<tr>
<td>2-08b</td>
<td>20°27’58.11”</td>
<td>86°58’41.49”</td>
<td>0.3</td>
<td>20.33</td>
<td>24.61</td>
<td>7.34</td>
<td>algae and sediment</td>
</tr>
<tr>
<td>3-08b</td>
<td>20°27’58.40”</td>
<td>86°58’41.70”</td>
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<td>20.41</td>
<td>24.88</td>
<td>7.40</td>
<td>algae</td>
</tr>
<tr>
<td>4-08c</td>
<td>20°27’56.80”</td>
<td>86°58’42.30”</td>
<td>0.5</td>
<td>20.30</td>
<td>25.07</td>
<td>7.45</td>
<td>algae and sediment</td>
</tr>
<tr>
<td>5-08c</td>
<td>20°27’58.55”</td>
<td>86°58’41.51”</td>
<td>0.3</td>
<td>19.68</td>
<td>24.67</td>
<td>7.37</td>
<td>algae</td>
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<tr>
<td>6-08c</td>
<td>Anchialine cave</td>
<td>8.0</td>
<td>34.71</td>
<td>26.03</td>
<td>7.74</td>
<td></td>
<td>sediment</td>
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</table>

a Collected February 15, 2006.
c Collected April 19, 2008.
Description. Both specimens incomplete, males, largest
with 20 chaetigers, 11-mm long and 1-mm wide including
parapodia, smaller specimen with 17 chaetigers, 9-mm long
and 1.2-mm wide including parapodia. Body elongate,
thoracic region barrel-shaped, partially inflated, with
narrow segments, abdominal region narrower, segments
longer. Prostomium broadly triangular; eyes absent.
Thorax with 9 chaetigers, the first and second are unique
in bearing heavy acicular spines, 2 or 3 in a fascicle, they
are known to occur in both notopodia and neuropodia
in the males, 3–7 with capillary chaetae. On chaetigers 8–9
(sometimes 6–8), enlarged opposing notopodial genital
spines are present. Abdominal segments with tori of
hooded hooks in slightly elevated ridges located closer
to the posterior end of the segment; single series of few uncini
numbering 5 to 10 in a row. Hooded hooks with long shafts
and distally end in recurved fangs surmounted by five
smaller teeth in two rows.
Habitat. Subtidal mud (Tagatz et al., 1982)
Distribution. Atlantic Ocean in Florida (Hartman,
1959), Costa Rica (Dean, 2004). This species is newly
recorded for Mexican waters.

Heteromastus filiformis (Claparède, 1864)
Material examined. Cenote Aerolito, Cozumel Island,
Quintana Roo, April 19, 2008 (2 specimens) in karst
sediment (CPICML-UNAM-PO-17-029).
Description. Both specimens incomplete, largest with 30
chaetigers, 7.5-mm long and 0.25-mm wide including
parapodia, smaller specimen with 20 chaetigers, 4.1-mm
long and 0.25-mm wide including parapodia. Prostomium
thin and conical; eyes absent. Eversible proboscis inflated,
with papillae, peristomium a single achaetous ring. Thorax
with 12 segments, first achaetous. Chaetigers 1–5 with
chaetae. Notochaetae very long capillaries and harpoon
body. Parapodia with abundant notochaetae and neuro-
chaetae. Notochaetae very long capillaries and harpoon
chaetae (stout pointed chaetae with recurved barbs near the
tip) of smaller size; three types of acicular neurochaetae:
subdistally flat, distally denticulate (3 to 5 teeth), subdis-
tally with a tooth and denticulate until the apex, with up to
15 small teeth. Notopodial cirri biarticulated and larger
than neuropodial cirri. Last segment encircling the anus.
Habitat. Associated to sessile organisms in rocky
substrate (Salazar-Vallejo, 1996–1997); in dead coral
(Ochoa-Rivera et al., 2000).
Distribution. Transatlantic and Mediterranean in trop-
ical and subtropical waters (Salazar-Vallejo, 1996–1997); in
the Mexican Caribbean previously reported from Cozumel
Island by Ochoa-Rivera et al. (2000).

Dorvilleidae Chamberlin, 1919
Ophryotrocha sp. A
Material examined. Cenote Aerolito, Cozumel Island,
Quintana Roo, February 15, 2006 (10 specimens), July 5,
2007 (758 specimens), April 19, 2008 (227 specimens) in
soft bottoms associated with mangrove roots, algae, and
karst sediments (CPICML-UNAM-PO-53-012).
Description. Most of the specimens complete with 12 to
15 chaetigers, 0.5- to 0.8-mm long and 0.4- to 0.5-mm wide
including parapodia. Body short, cylindrical, compressed
doorsventrally, tapering towards pygidium. Prostomium
bluntly triangular with two lateral antennae and ciliary
aggregations both in the frontal region and at the top.
Peristomium with two apodous rings. Parapodia unirra-
mous, with ventral retractile lobe and simple chaetae.
Supra-acicular fascicle with 2 to 3 simple chaetae, infra-
acicular fascicle with 4 to 5 heterogomph falcigers and one 
inferior-most simple Chaeta. Both types of chaetae finely 
serrated substidally, tapering to small distal tooth. Pygidium with one pair of minute ovate pygidial cirri. 
Jaw apparatus with elongate distally bifid mandibles with 
serrated cutting edge. Maxillary apparatus of P or K type; 
P type present in smallest specimens and K type in larger 
specimens. K-forceps distally falcate. D1–D7 denticles 
attached by ligament to forceps. With blue methyl dye a 
reduced ciliary distribution on each segment and pygidium 
is evident

Remarks. The maxillary apparatus known as P-type 
may have falcate or bidentate forceps and the number of 
free denticles ranging from five to seven pairs, while the 
maxillary apparatus known as K-type may have two 
unidentate, two bidentate, or one unidentate and one 
bidentate prong and the number of free denticles ranges 
from six to eight pairs; there may be one, two or three 
different kinds of denticles in one jaw apparatus. The 
remarkable feature here is that in these organisms, both 
types are found, depending on the size of the specimens, 
raising the question of the importance of this character to 
differentiate between species in this genus.

Other species of Ophryotrocha are opportunistic (Des-
bryères et al., 2006) and therefore found in many different 
habitats, which could explain why this species is so 
abundant here. Its status as a new species is presently 
under study.

Nereididae Johnston, 1865
Stenoninereis martini Wesenberg-Lund, 1959
Material examined. Cenote Aerolito, Cozumel Island, 
Quintana Roo, February 15, 2006 (14 specimens), July 5, 
2007 (203 specimens), April 19, 2008 (9 specimens) in soft 
bottoms associated with mangrove roots.

Comparative material examined. San Julián, Laguna de 
Términos, Campeche, Mexico 1 March 1984 (18 speci-

Description. Largest specimen complete with 33 chaet-
tigers, 10.5-mm long and 1.5-mm wide including parapo-
dia, smaller specimen complete with 21 chaetigers, 2.5-mm 
long and 0.6-mm wide. Prostomium pentagonal, slightly 
notched frontally. Two pairs of eyes. Frontal antennae 
cirriform and not longer than distal palps. Palps marginal, 
globular, biarticulate with elongate conical palpostyles. 
Peristomium slender with four pairs of tentacular cirri, 
anterior dorsal pair reaching posterior to chaetiger 6. Pharynx with paired jaws armed with 10 to 12 teeth, no 
paragnaths or papillae. First two parapodia subbiramous 
with notopodia reduced to small notoacicula; following 
parapodia biramous; anterior ones with long dorsal cirri 
consisting of elongate basal cirrophore and short pyriform 
cirrostyle, becoming longer towards end of the body. 
Notopodia trilobate, superior lobe short and digitiform, 
decreasing in size in posterior chaetigers; inferior lobes 
subulate, with small presetal lobe at base of upper lobe. 
Neuropodia with bluntly conical acicular lobe in anterior 
region, becoming more elongate in middle chaetigers and 
shorter, more pointed in posterior region. Supra-acicular 
notochaetae sesquigomph spinigers, infra-acicular noto-
chaetae homogomph spinigers; both with slender appendix, 
serrated on the inner edge. Supracircular neurochaetae 
heterogomph and sesquigomph spinigers; one hetero-
gomph spiniger with a strongly serrated short blade on at 
least three quarters of its length on its inner margin; 
heterogomph falcigers with spinuloose distally hooked long 
blade. Pygidium with a pair of lateral flattened, wide lobes, 
and a pair of long anal cirri.

Habitat. Soft bottoms associated with mangrove roots 
(de León-González and Solís-Weiss, 1997).

Distribution. Laguna de Términos, Campeche, Mexico 
(de León-González and Solís-Weiss, 1997), greater Carib-
bean region, San Martín Island, Sarasota Florida, western 
Gulf of Mexico (Texas), Cuba, North Carolina (Wesen-
berg-Lund, 1958; Pettibone, 1971; Hartman-Schröder, 
1977).

Syllidae Grube, 1850
Erinaceusyllis centroamericana (Hartmann-Schröder, 
1959)
Material examined. Cenote Aerolito, Cozumel Island, 
Quintana Roo, February 15, 2006 (1 specimen), July 5, 
2007 (4 specimens), April 19, 2008 (1 specimen) (CPICML-
UNAM-POH-076).

Description. One specimen complete with 21 chaetigers, 
1.5-mm long and 0.2-mm wide including parapodia. Body 
small, covered with small, scattered papillae. Prostomium 
oval with 4 small eyes in rectangular arrangement and 2 
anterior eyespots; antennae pyriform, median and lateral 
antennae similar in size. Palps short, fused along their length. 
Peristomium long, tentacular cirri similar to antennae. 
Dorsal cirri similar to antennae, with bulbous bases and 
short tips, absent on chaetiger 2. Ventral cirri digitiform. 
Compound chaetae heterogomph, similar throughout body; 
blades slender, elongate, unidentate, distally slightly hooked, 
provided with proportionally long marginal spines on bases 
of longer blades; parapodia each with one long bladed 
compound chaeta and 6 falcigers. From chaetiger 1, simple 
unidentate chaeta with short marginal spines dorsally. 
Simple chaetae ventrally. Aciculae acuminate, one per 
parapodium throughout the body. Pharynx extending from 
chaetigers 1 to 3 or even 4; pharyngeal tooth small and 
enlarged on anterior margin. Proventricle barrel-shaped, 
extending from chaetigers 3–6; with about 13 to 16 rows of 
transverse muscle bands. Pygidium small, with two anal cirri.

Habitat. In sand, algae and mangroves (San Martín, 
2005).

Distribution. Circumtropical: El Salvador, Galápagos 
Islands, Caribbean Sea, Hawaii, Samoa, Angola, Mozam-
bique, Tanzania, Australia (San Martín, 2005). New record 
for Mexican Caribbean.
First records of polychaetous annelids from Cenote Aerolito (sinkhole and anchialine cave) in Cozumel Island, Mexico

Salvatoria sp. 1

Material examined. Cenote Aerolito, Cozumel Island, Quintana Roo, July 5, 2007 (4 specimens), in soft bottoms associated with mangrove roots, algae, and karst sediments (CPICML-UNAM-PO-37-077).

Description. All specimens incomplete, largest with 21 chaetigers, 1.8-mm long and 0.25-mm wide including parapodia. Body small. Prostomium with 3 antennae, 4 eyes and, usually, without 2 eyespots. Palps well developed, joined along their length by a dorsal membrane. Two pairs of tentacular cirri. Antennae tentacular, dorsal cirri long and slender, slightly bulbous at their base and with an elongate, acute tip; dorsal cirri present on all segments. Ventral cirri digitiform, shorter than parapodial lobes. Compound chaetae heterogomph with small indistinct subdistal tooth; dorsal simple chaetae bidentate, with short subdistal marginal spines, ventral simple chaetae not observed. Acicula distally rounded, one per parapodium throughout the body. Pharynx extending through chaetigers 1–3, surrounded by a crown of 12 soft pharyngeal papillae and a small tooth on anterior margin; proventricle of the same length through chaetigers 4–6, with about 19 rows of transverse muscle bands. Pygidium unknown.

Exogone (Paraexogone) sp. 1

Material examined. Cenote Aerolito, Cozumel Island, Quintana Roo, July 5, 2007 (1 specimen), in soft bottoms associated with mangrove roots and algae (CPICML-UNAM-PO-37-077).

Description. Specimen incomplete with 15 chaetigers, 0.5-mm long and 0.2-mm wide. Body small and slender. Prostomium without antennae, four eyes with 2 eyespots. Palps slender, well developed, completely fused to each other. Tentacular cirri fragmented. Dorsal cirri small, ovoid, present on all segments. Compound chaetae falciigers, incomplete and no spiniigers visible, dorsal bifid simple chaetae present from first chaetiger. Acicula distally truncate. Pharynx sinuous, extending through chaetigers 1 and 2, pharyngeal tooth small on anterior margin. Proventricle through chaetigers 2–4, with about 22 rows of transverse muscle bands. Pygidium unknown.

Syllis prolifera Krohn, 1852


Description. Largest specimen complete with 48 chaetigers, 9-mm long and 0.25-mm wide. Body thick. Prostomium oval with 4 small eyes in trapezoidal arrangement; median antennae longer than prostomium and palps together, with about 24 articles; lateral antennae with about 29 or 30 articles. Palps triangular, robust, larger than prostomium. Dorsal tentacular cirri long, with about 37 to 45 articles; ventral tentacular cirri with about 33 to 38 articles. Dorsal cirri long and slender, with about 45 to 52 articles. Ventral cirri digitiform. Compound chaetae falciigers, strongly bidentate with teeth of similar size. Aciculae rounded with hollow tips; their number changes depending on body region, four in anterior and median region and only one in posterior region; dorsal bifid simple chaetae present from chaetiger 18 and ventral simple chaetae only present in posterior chaetigers. Pharynx extending through chaetigers 1–7; pharyngeal tooth small on middle dorsal position. Proventricle through chaetigers 7–10, with about 25 rows of transverse muscle bands. Pygidium small, with two anal cirri with 28 to 30 articles.


Distribution. A cosmopolitan species in tropical and temperate seas (San Martín, 2003). The closest record to the study area is Cuba (San Martín, 1992).

Syllis maryae San Martín, 1992

Material examined. Cenote Aerolito, Cozumel Island, Quintana Roo, April 19, 2008 (1 specimen) (CPICML-UNAM-POH-37-045).

Description. Specimen complete with 61 chaetigers, 8.5-mm long and 0.5-mm wide. Body thick. Prostomium oval with 4 small eyes in trapezoidal arrangement; median antennae longer than prostomium and palps together, with about 25 articles; lateral antennae, with about 12 to 14 articles. Palps triangular, similar in length to prostomium. Dorsal tentacular cirri long, with about 13 to 15 articles; ventral tentacular cirri with 10 to 12 articles. Dorsal cirri slender, alternating long (23 to 26 articles) and short (10 to 16 articles). Ventral cirri digitiform. Dorsal glands on segments 14–16. Compound chaetae including 1 or 2 bidentate pseudospinigers with teeth of similar size and about 6 bidentate falciigers with proximal tooth shorter than distal one, and with short spines on cutting margin with dorsoventral gradation. Aciculae distally truncate, forming a right angle, their number changing along the body, two in anterior and median region and only one in posterior region. Pharynx extending through chaetigers 1–7; pharyngeal tooth small on anterior margin. Proventricle through chaetigers 7–10, with about 29 rows of transverse muscle bands. Pygidium small, with two anal cirri with 16 to 18 articles.

Habitat. Shells (San Martín, 1992), dead coral (Granados-Barba et al., 2003).

Distribution. North Carolina, Cuba (San Martín, 1992), Gulf of Mexico (Granados-Barba et al., 2003).

Seasonal Species Occurrence

In this study, the family Dorvilleidae is dominant, with 995 specimens or 65.5% of the polychaetes collected, although it is represented by only one species, Ophryotrocha sp. A. Some differences in seasonal distribution were noted. In July 2007 and April 2008, Paradoneis lyra was absent, while in February 2006 it was by far the most abundant species (75% of the total). Syllis prolifera was present only in July 2007, Capitella aciculatus and...
Heteromastus filiformis where present only in April 2008, and the specimens of Salvatoria sp.1 and Exogone sp.1 were present only in July 2007. In all samples and at almost all stations, except in the cave system, (February 2006, July 2007, and April 2008) the Capitella capitata species complex and Ophryotrocha sp. A, were present (Table 2). The differences observed in species composition and distribution are recorded here as part of this first study on the polychaete fauna of Mexican cenotes, but cannot be fully interpreted at this point until more sampling is carried out. Nevertheless, this study documents both the fact that polychaetes are present and diversified in this habitat, and that seasonal changes or species replacements might take place. It is interesting to note that, in the second sampling period, epitokes were collected from the families Nereididae and Syllidae, while none were present in the first and third sampling periods.

Bottom-water salinity and temperature were different in each sampling period. In February 2006, the salinity was 18.1 ppt with a temperature of 25 °C, in July 2007 the salinity was between 15 and 15.8 ppt and temperature 26.89 to 27.08 °C whereas in April 2008 the salinity was between 19.68 and 20.33 ppt and temperature 24.61 to 24.88 °C. In the cave system, the salinity was 34.71 ppt and temperature 26.03 °C. The sediment in the cave consists of sand of biogenic origin (very fine coral debris).

**DISCUSSION**

Since this is the first study about polychaetes in cenotes in Mexico, all records are new for Cenote Aerolito itself and its cave system, but so far only the dominant species Ophryotrocha sp. A is potentially new to science.

The polychaete species already recorded for the Cozumel area include Hermodice carunculata and the so-called complex of species under the name Capitella capitata, both recorded from dead coral (Ochoa-Rivera et al., 2000). In this case, the presence of this species complex could be attributed to the abundance of organic matter (mangrove roots, algae) in which the species complex is known to thrive.

At the regional scale, Stenoninereis martini is known from Florida, down to the Gulf of Mexico (Términos lagoon) and the greater Caribbean (de León-González and Solís-Weiss, 1997), and the capitellids Capitella aciculatus and Heteromastus filiformis have also been recorded previously for the greater Caribbean. Although some species of Exogoninae of the Caribbean have been reported by Ruiz-Ramirez and Salazar-Vallejo (2000), the species Erinaceusyllis centroamericana is a new record for the Mexican Caribbean. This species had been previously recorded from the West Indies (San Martín, 2005). Syllis prolifea is considered cosmopolitan but, like Syllis maryae, the closest records to the study area are from Cuba and the Gulf of Mexico (San Martín 1992; 2003).

**CONCLUSIONS**

This first study on polychaetous annelids in Mexican cenotes revealed a relatively diversified (10 genera and 11 species) and interesting polychaete fauna in the best-known and most popular cenote on Cozumel Island. We believe that the underwater connection to the sea, in addition to the nearby mangrove habitat, create propitious conditions for Polychaeta, and many other species can be expected in these unique habitats.

Even though there are important differences between the cenote habitat and a truly marine one, no morphological differences could be observed in any of the species recorded, with the possible exception of the Ophryotrocha sp. 1.

Although the best-represented macrofaunal invertebrate animal group in caves and also cenotes is macrofaunal crustaceans (Schmitter-Soto et al., 2002; Mejía-Ortíz et al., 2007b), more recent studies are revealing new taxa. Mejía-Ortíz et al. (2007a) and Solís-Marín and Laguarda-Figuera (2008), for example, found species of all the echinoderm classes except the Crinoidea for the system of caves connected to Cenote Aerolito.

In addition, this study constitutes a baseline study that will be especially important because the cenote is on the verge of being severely transformed by the construction of a marina at its western end, which will include the destruction of the cave in creating a direct connection between the marina area of the cenote to the sea. This will certainly affect the local fauna as we know it now, not only because of the change in salinity, which will become like the surrounding sea, but because of the construction itself and subsequent maritime traffic. All this impact will change the environmental conditions and not only the polychaete composition but also the other fauna groups already recorded.

There is concern in the scientific community, because legislation concerning the cenotes in Mexico is not yet well defined. They are not differentiated from other freshwater bodies, so they cannot be properly protected. The Mexican government agency CONAGUA (Comisión Nacional del Agua) has only begun in 2009 to work on a legal framework to promote the sustainable use and conservation of these unique water bodies.

**ACKNOWLEDGEMENTS**

We are grateful to Alfredo Laguarda and Francisco Solís, from the Instituto de Ciencias del Mar y Limnología, UNAM, as well as to divers Germán Yáñez, Adrian Medina, and Emmanuel Teyssier, for their help in the field, and to Diego Trujillo and Efrain Chávez for their help in collecting the cave samples. Victor Ochoa, María Elena García, and Pablo Hernández are also thanked for their help in some identifications. Antonio Márquez, Laboratorio de Sedimen-
Table 2. Abundance of polychaetes collected in Cenote Aerolito and its anchialine cave in 2006–2008.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Stations</th>
<th>Total</th>
<th>Specimens</th>
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<tr>
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<td>1-06</td>
<td>1-07</td>
<td>2-07</td>
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<tr>
<td>Family Capitellidae Grube, 1862</td>
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<td>Capitella (Fabricius, 1780)</td>
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<tr>
<td>Capitella capitata s.s.</td>
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<tr>
<td>Capitella aciculata (Hartman, 1959)</td>
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<td>Heteromastus filiformis (Claparede, 1864)</td>
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<td>Paradoneis lyra (Southern, 1914)</td>
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<td>Family Amphinomidae Lamarck, 1818</td>
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<td>Hermodice carunculata (Pallas, 1766)</td>
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<td>Syllis prolifera Krohn, 1852</td>
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<td>Syllis maryae San Martin, 1992</td>
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</table>

FIRST RECORDS OF POLYCHAETOUS ANNELED FROM CENOTE AEROLITO (SINKHOLE AND ANCHIALINE CAVE) IN COZUMEL ISLAND, MEXICO
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