

*Evermannia erici*, a new burrowing gobiid fish  
from the Pacific coast of Costa Rica

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**Abstract:** A new species of the four-spined goby genus *Evermannia* is described from the intertidal zone at two localities on the Pacific coast of Costa Rica. Observations are included on the ecology and behavior of the species. Proportional and meristic data for Costa Rican specimens of *Evermannia zosterura* and *E. panamensis* are provided for the first time.

Two species of the genus *Evermannia* are known from the intertidal regions of Mexico, Panama, Colombia and Peru. A third species from the Gulf of California provisionally referred to the genus *Evermannia* and with a confused taxonomic history, is not seriously considered here as a member of the genus. Little is known of their systematic relationships and natural history. The present paper describes a third species of the genus and reveals something of the life habits of this inconspicuous little fish which occupies some of the most heavily transited beaches in Costa Rica.

*Evermannia erici*, new species  
(Figs. 1a and 1b)

**Holotype:** LACM 42996-1: an adult male 21.9mm standard length taken in front of Hotel Jacó Beach at Jacó, just south of Bahía Herradura, Pacific coast of Costa Rica, by hand on a wet patch of beach 10 m from the water in a burrow of fine sand on 13 October 1979 by Myrna, Eric and W. Bussing.

**Paratypes:** UCR 1309-1: same data as holotype; 15 specimens (12.5-19.8 mm SL standard length). UCR 1321-1: Playa Tamarindo on beach in front of Hotel Tamarindo Diríá, Pacific coast of Costa Rica; 6 February 1980; collected by M., E. and W. Bussing; 81 specimens - 5 cleared and stained (9.1-23.5 mm SL). UCR 1322-1: Playa Tamarindo in tide pool just S of Estero Tamarindo; 8 February 1980; collected by M., E. and W. Bussing; 14 speci-

mens (12.7-23.2 mm SL). UCR 1357-1: Playa Tamarindo in tide pool and stream just S of Estero Tamarindo; 18 February 1982; collected by M., E., Ilse and W. Bussing; 63 specimens (14.0-23.7 mm SL). LACM 42997-1: same data as UCR 1357-1; 30 specimens (13.8-24.8 mm SL). USNM 254313: same data as UCR 1357-1; 30 specimens (18.8-22.6 mm SL).

**Comparative material:** *Evermannia panamensis* Gilbert and Starks. UCR 699-1: Puerto Jiménez, Golfo Dulce, Pacific coast of Costa Rica, at mouth of shallow stream on mud-sand bottom; 20 March 1972; collected by J.E. McCosker; 38 specimens - 3 cleared and stained (21.8-40.0 mm SL). *Evermannia zosterura* (Jordan and Gilbert). - UCR 60-2: Estero Mata Limón just S of Caldera, Pacific coast of Costa Rica in a tidepool near mangroves; 21 August 1966; taken by J.D. Villa; 1 specimen (24.0 mm SL). UCR 320-28: Estero Mata Limón; 23 May 1969: collected by W. Bussing, J. Perry and R. Nishimoto; 5 specimens (17.8-25.4 mm SL). UCR 420-3: Estero Mata Limón; 11 March to 5 May 1969; collected by J. and S. Perry; 11 specimens - 3 cleared and stained (15.3-25.8 mm SL). In addition to the cleared and alizarin stained material mentioned above, radiographs were made of 10 specimens each of *E. erici* (UCR 1321-1), *E. panamensis* (UCR 699-1) and *E. zosterura* (UCR 420-3) to obtain vertebral counts and confirm fin ray counts. Type

material is deposited at the Natural History Museum of Los Angeles County (LACM), Museo de Zoología, Universidad de Costa Rica (UCR) and the National Museum of Natural History (USNM).

**Diagnosis:** A small species of *Evermannia* distinguished from its two congeners by the absence of a prolonged filamentous first dorsal spine in the male, that of both sexes being quite short and shorter than the first dorsal spine of either sex of its congeners (8.4-12.1 vs 2.4-5.4 times in SL). In addition, *E. erici* differs from local *E. zosterura* in having more dorsal fin-rays (usually 15 vs 14), more pectoral fin-rays (20 or 21 vs 17-19) and more precaudal vertebrae (usually 14 vs 13). The new species is very similar meristically to *E. panamensis*, varying only in average differences: *E. erici* has fewer dorsal fin-rays (usually 15 vs 16) and fewer anal fin-rays (usually 13 vs 14). *E. panamensis* is a larger species, more extensively scaled and the males much more darkly pigmented than *E. erici*. All three species have black (male) or dusky (female) bands on anal and caudal fins and a general speckled ground color. *Gobiosoma longipinne* Steindachner was provisionally referred to *Evermannia* (Jordan, 1896), but it still retains a dubious status and is distinguished by its total lack of squamation and long upper jaw extending an eye's diameter beyond the posterior border of the eye.

**Description:** Comparative meristic counts and body proportions in permillage of standard length of the three species of *Evermannia* are presented in Tables 1 and 2, respectively. Body extremely slender, depth diminishing posterior to pelvic fin; greatest body depth (at pelvic fin origin) 5.6-6.5 times in SL; least depth of caudal peduncle 15.1-16.0 times in SL. Body width less than head width and diminishing toward caudal fin-base. Predorsal profile convex, the mesethmoid bones projecting prominently above the upper lip; from dorsal fin origin profile straight to caudal fin-base. Ventral profile straight, usually with an abdominal concavity posterior to pelvic fins.

Head rather long (2.9-3.3 times in SL); slightly wider than high, greatest width at preopercular margin. Eyes small, not protruding above head profile, directed laterally; horizontal orbit diameter 4.5-5.6 times in head length. Bony interorbital distance very narrow,

2.8-6.0 times in orbit diameter. Snout length usually slightly greater than orbit diameter, 3.9-5.0 times in head length.

Lateralis-system head pores reduced to three pairs on upper part of head. Nomenclature follows Hoese (1971:18): a pair of posterior nasal pores; a pair of posterior interorbital pores close to mid-dorsal line; a pair of supra-orbital pores. No other lateral line canals or pores were observed.

Head papillae circular and slightly raised (seen best on slightly moist specimens), reduced to a few rows. A row of four papillae between each posterior nasal pore and upper jaw; a diagonal row of numerous papillae between anteroventral margin of eye and upper jaw; a single papilla anteroventrad to each supraorbital pore; two papillae at upper margin of preopercle; a transverse row of many papillae running parallel to and slightly behind posterior border of preopercle; several papillae in diagonal row on upper half of opercle; a fringing row running just above each maxillary, a similar row along ventral margin of dentaries and continuing along anterior branch of preopercle and partly up posterior margin of preopercle.

Mouth large in both sexes; slightly inclined. Upper jaw usually reaching more than pupil diameter beyond posterior margin of eye in males (143-154 % of SL) and usually less than pupil diameter in females (135-142 % of SL). Upper and lower jaw teeth in two irregular rows anteriorly, becoming uniserial posteriorly. Outer row of teeth enlarged and recurved, no sexual differences.

Squamation reduced to scattered nonimbricate cycloid scales on urosome. A series of about 16 minute scales on lateral midline from base of caudal fin to about third anal fin-ray. On some specimens a similar series above and below midline, but not extending as far anteriorly. Scales visible on slightly dried specimens; difficult to see on cleared and stained material because of slight degree of ossification and small size. Gill rakers 3-5 + 7-8 = 10-12, holotype 4 + 8 = 12. Vertebrae 13-14 + 17-18 = 30-32, count not determined on holotype.

First dorsal fin invariably with four spines, last spine separated from others by a distance twice that separating first three spines; first spine not produced into long filament in either sex, length 8.4-12.1 times in SL. Second dorsal

TABLE 1

*Meristic variation of second dorsal fin-rays, and fin-rays, pectoral fin-rays total gill rakers on first gill arch and precaudal, caudal and total vertebral counts in Costa Rican populations of Evermannia erici, new species (UCR 1309-1, 1321-1 and 1357-1), E. zosterura (UCR 60-2, 320-28 and 420-3) and E. panamensis (UCR 699-1)*

	D rays				A rays			P <sub>1</sub> rays					
	13	14	15	16	12	13	14	17	18	19	20	21	22
<i>E. erici</i>		1	23	6		23	7				16	4	
<i>E. zosterura</i>	1	8	1			8	2	1	5	4			
<i>E. panamensis</i>		1	2	7	2	2	8			7	2	1	

	Gill rakers					Vertebrae						
	10	11	12	13	14	Pre C		C		Total		
<i>E. erici</i>	2	7	11			13	14	17	18	30	31	32
<i>E. zosterura</i>		2	2	2	4	13		13		13	6	2
<i>E. panamensis</i>		2	7	1		2	11	12	1	2	10	1

TABLE 2

*Body proportions in permillage of standard length of holotype (LACM 42996-1) and selected paratypes (UCR 1309-1 and 1357-1) of Evermannia erici, new species. E. zosterura (UCR 60-2, 320-28 and 420-3) and E. panamensis (UCR 699-1)*

	<i>Evermannia erici</i>			<i>E. zosterura</i>	<i>E. panamensis</i>
	Holotype (male)	Paratypes (10 males)	Paratypes (10 females)	(5 males, 5 females)	(5 males, 5 females)
Standard length in mm	21.9	18.2-24.1	17.1-22.2	17.8-25.8	22.5-40.0
Head length	329	304-349	313-330	333-363	317-360
Orbit diameter	68	58-69	62-71	66-79	60-80
Bony interorbital	18	11-21	13-23	10-21	13-23
Snout length	78	67-85	64-85	71-92	66-77
Length of upper jaw	146	143-154	135-142	132-155	142-178
Body depth (at pelvic origin)	174	165-178	155-176	174-208	159-187
Least depth caudal peduncle	68	63-78	66-90	81-95	78-84
Predorsal distance	411	393-434	405-421	413-459	403-444
Preanal distance	639	593-652	614-647	601-650	596-647
Length first dorsal spine	96	83-118	93-119	185-413	196-369
Length base second dorsal fin	333	285-370	333-365	330-343	332-363
Length base anal fin	274	269-299	250-287	282-309	278-317

fin-rays (last ray divided to base and counted as one) 14-16, holotype 15; length of fin base 2.7-3.5 times in SL. Predorsal distance 2.3-2.6 times in SL. Anal fin-rays (last divided to base and counted as one) 13 or 14, holotype 13; length of fin base 3.4-4.0 times in SL. Preanal

distance 1.5-1.7 times in SL. Pectoral fin-rays 20 or 21, holotype 20. On five cleared and stained specimens 14 segmented caudal rays, 6 or 7 upper and 6 lower procurent caudal rays.

Background color translucent in life, whitish in alcohol. Epidermal pigments consisting of

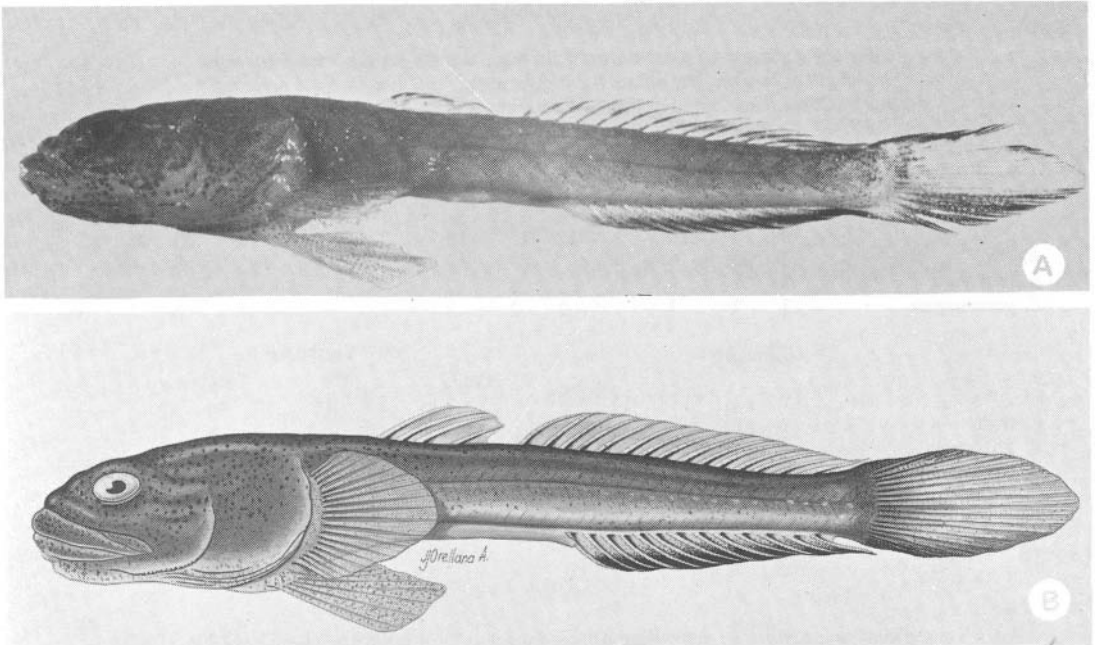


Fig. 1. *Evermannia erici*, new species, LACM 42996-1, adult male holotype 21.9 mm SL from Playa Jacó, Costa Rica, A. Photograph of holotype, B. Camera lucida drawing of holotype showing scale pattern as seen on a cleared and alizarin-stained adult male paratype (UCR 1321-1).

pupil-sized white guanine blotches overlaid by rather evenly scattered individual brown or black melanophores. Effective pattern evenly speckled or specific melanophores expanded to create black blotches along dorsal midline or crosshatching on upper half of body. Belly white. Melanophores of lower half of head enlarged; on females a few melanophores on tip of chin, on males covering entire throat and isthmus. Resultant color pattern of fish highly cryptic against sand substrate of habitat.

Distal three-quarters of first dorsal spine black, base transparent; tip or most of fourth spine also black; remainder of fin transparent. Rays of second dorsal fin usually with melanophores proximally, a clear area and remaining four-fifths of ray blackened; interradiation membranes transparent. Anal fin transparent proximally, distal two-thirds, including rays and interradiation membranes, dusky (females) or jet black (males); extreme tips of anal rays usually white creating a thin (males) or wider (females) white distal margin to anal fin. Caudal fin of females transparent with black speckling especially concentrated on dorsal margin, forming a dark vertical bar on

caudal base and a general duskiess on lower third of fin. In males caudal pigmentation is intenser, forming a continuous thin black upper margin and a black lower third continuing the black marking of anal fin. Pectoral fins speckled with melanophores; pelvics in females usually transparent, dusky in males.

**Etymology:** The species is named for my son Eric A. Bussing who first called attention to these inconspicuous fishes and captured several by hand to convince me they were not really the young of other goby species stranded by the outgoing tide.

**Sexual dimorphism:** To summarize, males can be most readily distinguished by the intense black pigmentation on the throat and anal and caudal fins. The longer upper jaw of the males, typical of other goby species, also separates the sexes of mature specimens (males 143-154, females 135-142  $\sigma/\sigma$  of SL).

**Ecology:** The principal habitat of *E. erici* is in the intertidal zone of sandy beaches. They inhabit approximately the upper half of the

littoral zone in colonies where wet patches are maintained at low tide due to seepage from the supralittoral zone. They apparently remain in burrows during high tides and are active in shallow troughs a few millimeters deep during diurnal low tides. *E. erici* is occasionally seen in shallow sandy pools at the base of rocks in the upper half of the littoral zone; it is replaced in the lower intertidal zone by another goby, *Bathygobius ramosus*. It was abundant also at low tide in a small tide pool a few centimeters deep and in a stream draining the pool.

The following account is based on observations at Playa Tamarindo (UCR 1322-1) intermittently during a 36 hour period on 6 and 7 February 1980. During this period vertical tidal fluctuations varied from 0.2 to 2.6 m above mean sea level and the width of the intertidal zone was 82 m. Most of the exposed sand was dry, but a roughly triangular patch of sand remained covered by a few millimeters of water. Its base was 56 m long starting about 12 m below the high tide mark and extending 24 m to its apex about 46 m from low tide level.

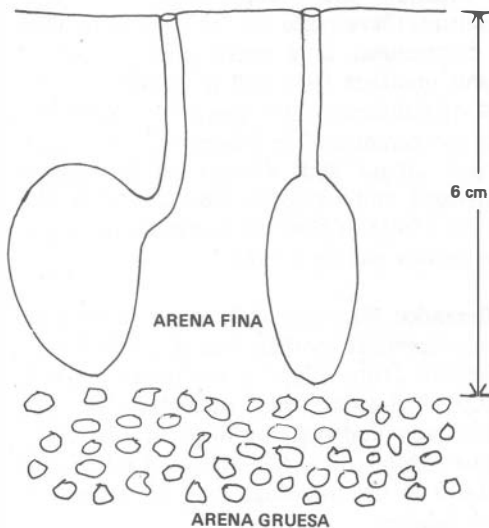


Fig. 2. Typical burrow of *Evermannia erici*, new species; two views of same burrow.

6 February 1980, 1000 to 1310 hours (low tide 0.2 m at 1209 hrs.): Specimens of *E. erici* were seen inhabiting troughs in riffle marks running parallel to the shore line. Each trough usually had one or more round holes into which fish would disappear if pursued. Fish and burrow entrances were observed in a central area never

closer than about 5 m from the extreme borders of the large wet patch. Average density of fishes was estimated at  $10/\text{m}^2$ . The openings to the burrows were just wide enough to permit the fish to enter and led vertically 3 cm down to an enlarged cavern about 2-3 cm in diameter and slightly compressed (Fig. 2). The entrance tunnel and cavern were situated in a layer of fine sand 5-7 cm deep overlying a coarse sand and gravel layer. It is not clear how the burrow system was kept from collapsing in the saturated sand substrate. Fish were observed excavating burrows by entering head first, retreating tail first with the tail vibrating vigorously and depositing sand, then repeating the process. Numerous fish were observed outside of the burrows feeding and occasionally exhibiting courtship behavior. Feeding is accomplished by repeatedly taking large mouthfuls of sand from the margins of the shallow furrow being occupied. The sand is apparently sifted for small interstitial organisms such as crustaceans and polychaetes and upon separation was continuously passed out the gill opening as in some other substrate-sifting fishes. Apparent courtship behavior involved the male erecting its fins and presenting a lateral display to the female while vibrating his body and rapidly shifting his position close to the female. This behavior was observed between a pair of fish in a 2 m long trough with one hole near each end. A male was in the vicinity of each hole and the female apparently lacked its own burrow. After considerable display by the male, the female entered the male's burrow and left head first about a minute later. Several females were seen in small depressions without entrances to burrows. Excavated burrows revealed males, females and immature specimens. Juveniles were most frequent in the upper part of the colony. As water temperatures increased fish activity decreased and many fish retired to their burrows. Water temperature, estimated at 30 C at this time, was cooler than expected due to a slight surface flow to the lower littoral zone.

1445 hours: The incoming tide was reaching the lowest burrows in the colony. No burrow entrances were visible under water as they probably are temporarily closed by the shifting sand. No fish were seen along the shoreline. Average density of fish outside their burrows about  $1/\text{m}^2$ .

1600-1630 hours (high tide 2.6 m at 1832):

Incoming waves were reaching the upper limit of the *Evermannia* colony at 1615 hours. No free-swimming fish were seen. Burrow entrances were seen to be obliterated by the first two or three waves to reach the area. Although difficult to excavate intact, six burrows were removed, but a fish was found in only two of them. One of these fish was released above an incoming wave. The fish immediately began deepening its shallow depression in the sand by rapid fluttering of the pectoral fins; it then plunged its head in the sand and began to remove mouthfuls of sand, using a backward swimming movement. Soon it turned around and left the new burrow head first while continuing to excavate. Excavation continued as the first six waves washed over the site. After several minutes of repeated attempts to maintain an opening to the burrow, it finally remained silted in. At the last opportunity the substrate with the fish was lifted out revealing a small burrow about 3 cm deep. It is probable that this species remains in its burrows during high tides and thus reduces predation to a minimum.

7 February 1980, 0915 to 1000 hours (high tide 2.3 m at 0648 hrs.): The receding tide had uncovered the upper 10 m of the colony. Numerous 20-30 cm long furrows were occupied by feeding fish; these former riffle marks running parallel to shore were modified by the feeding activity of the fish which created innumerable dendritic branches running in all directions from the main channel. Density was estimated at 6 or 7 fish/m<sup>2</sup>. Each channel usually contained a single burrow entrance and fish, although some contained two holes and up to three fish. Large females generally occupied channels without holes and when approached were difficult to chase into burrows; males present would rapidly hide in the burrows. As the outgoing tide progressively uncovered more of the colony, large and small fish would appear in the shallow riffle troughs and begin to deepen the channel and, if a male, begin excavating a burrow. Other organisms observed in the region include gastropods of the genera *Oliva* and *Olivella* on the surface and small crustaceans and polychaete worms in the sand.

1030-1130 hours (low tide 0.3 m at 1246 hrs.): We inspected a 1.5 km stretch of beach following the bay to the north. Only a few *E. erici* were observed in small isolated wet patches of low gradient and in small pools

surrounding isolated rock outcroppings in the upper two thirds of the littoral zone. At the end of this stretch near the mouth of Tamarindo estuary a shallow sandy depression was draining into the retreating waves. Numerous *E. erici* were active on the sandy bottom especially near the outlet in the current and in the small stream draining the pool.

2230 hours (high tide 2.5 m at 1912 hrs.): The entire colony was exposed, but no fish were seen nor evidence of their activity in the riffle marks. Only ten burrow entrances were observed in the entire colony. Only one fish was obtained from a burrow, but several were seen in pools around rocks. The species was active however between 1700 and 1730 hours during a low tide at Playa Jacó (UCR 1309-1).

Ripe females were present in both the October and February collections. Specimens from both Jacó and Tamarindo contained as many as 17 small isopods and large quantities of sand. Some specimens contained only sand in the digestive tract.

Other species of gobies bury themselves in the substrate and occupy burrows of other organisms. *Clevelandia ios*, which may be allied to *Evermannia*, is a small goby known to inhabit mudflats from British Columbia to the Gulf of California. This species is known as a common commensal in burrows of the echinurid *Urechis caupo* and shrimps of the genera *Callinassa* and *Upogebia* (MacGinitie & MacGinitie, 1949). It does not however excavate its own burrow as does *E. erici*.

**Remarks:** Members of the genus *Evermannia* are characterized by their four dorsal fin spines, a flexible dermal flap on the shoulder girdle, minute embedded and nonimbricate scales visible only under strong magnification and a unique habitat of as few as several millimeters of water in the intertidal zone of estuaries or sandy beaches.

*Evermannia zosterura* (Jordan & Gilbert) was first described from Mazatlán, México as *Gobiosoma zosterura* and later made the genotype of *Evermannia* by Jordan (1895). Gilbert & Starks (1904) collected additional specimens in tide pools at Panama and commented on the close similarity of *Evermannia* and *Ilypnus* and somewhat lesser relationship to *Clevelandia*; they also described *E. panamensis* from tide pools on the Panama reef. Meek & Hildebrand (1928) did not take

these two species in their Panamanian survey, but included descriptions and a key to the species. Nichols & Murphy (1944) reported seven specimens of *E. zosterura* from Ensenada Coredó, Colombia; they were collected "...from slender, cylindrical burrows in a sandy beach just above the wash of the surf at half tide". Costa Rican specimens of these two species were collected from estuarine environments rather than reef pools or sandy beaches.

Jordan (1896) provisionally referred *G. longipinne* Steindachner from the Gulf of California to *Evermannia* on the basis of its supposedly naked body and other characteristics. It has four to six dorsal fin-spines and a long upper jaw like *C. ios*, but unlike that species is supposed to have no scales. Jordan & Evermann (1898) even wrote Dr. Steindachner to confirm this, suggesting their uncertainty regarding the validity of this species. It had been erroneously reported from Southern California and Washington by Eigenmann & Eigenmann (1888) as *Clevelandia longipinnis* (= *C. ios*). The species was cited as late as 1936 by Barnhart as *Evermannia longipinnis* with a distribution of the Gulf of California to Southern California. In recent works *E. longipinnis* has not been included as a member of the California ichthyofauna (Hubbs *et al.*, 1979) and its status as a member of the genus *Evermannia* is uncertain. The final determination of its status lies outside the scope of the present study.

**Distribution:** *Evermannia erici* was collected from the northwestern and central sectors of the Pacific coastline of Costa Rica. A more extensive range to both north and south is to be expected.

#### ACKNOWLEDGMENTS

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J.J. Orellana A. who painstakingly produced the drawing of *E. erici* in Fig. 1B.

#### RESUMEN

Se describe una especie nueva de gobio de cuatro espinas dorsales del género *Evermannia* de la zona entremareas en dos localidades de la costa pacífica de Costa Rica. Se incluyen observaciones sobre la ecología y comportamiento de la especie además de datos proporcionales y conteos de ejemplares costarricenses de *E. zosterura* y *E. panamensis*.

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