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New records of snipe eels (Anguilliformes: Nemichthyidae) from the Pacific coast of lower Central America

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Abstract

Background: New records of occurrence of two snipe eels (*Avocettina bowersii* and *Nemichthys scolopaceus*), poorly known for the Pacific coast of Costa Rica and Panama are herein reported.

Results: Specimens, 45 in total (28 and 17, respectively), were collected between 1972 and 1973 at depths between 295 and 1000 m. Descriptions based on specimens as well as comparative morphometric and distributional information by species are herein presented and discussed. A key to the identification of the eastern Pacific species of the family also is presented.

Conclusion: These findings increase the knowledge on the Central American marine ichthyofauna and provide evidence of a broader distributional pattern for these species in the eastern Pacific region.

Keywords: *Avocettina bowersii*, *Nemichthys scolopaceus*, Eastern Pacific, Costa Rica, Panama, Deep-waters

Background

The Nemichthyidae represent a small group of highly modified pelagic fishes distributed in all tropical and temperate seas at depths down to 4000 m (Garman 1899; Nelson 2006; Fishbase 2015). Members of the family, commonly known as snipe eels, are characterized by having very elongate scaleless bodies, non-occlusible and beak-like jaws (except in fully mature males), pectoral fins present, dorsal and anal fins confluent with caudal fin, and 170 to over 750 vertebrae, among other distinctive characters (Nelson 2006; Nielsen & Smith 1978).

Currently, three genera (*Avocettina* Jordan & Davis, 1891; *Labichthys* Gill & Ryder, 1883; and *Nemichthys* Richardson, 1848) and nine species of snipe eels are recognized as valid (Catalog of Fishes, 2015). The genus *Avocettina* with four species [*A. acuticeps* (Regan, 1916); *A. bowersii* (Garman, 1899); *A. infans* (Günther, 1878); and *A. paucipora* Nielsen & Smith, 1978] is the most diverse; whereas *Nemichthys* and *Labichthys* are represented by three and two species respectively [*N. scolopaceus* Richardson, 1848; *N. curvirostris* (Strömman, 1896); *N. larseni* Nielsen & Smith, 1978; *L. carinatus* Gill & Ryder, 1883; and *L. yanoi* (Mead & Rubinoff, 1966)].

In the eastern Pacific Ocean five species of snipe eels have been recorded (*A. bowersii*; *A. infans*; *N. curvirostris*; *N. larseni*; and *N. scolopaceus*) (Garman 1899; Fishbase 2015); Nielsen & Smith 1978; Pequeño 1989; Charter 1996; Catalog of Fishes 2015). Two species are restricted to the central and eastern Pacific (*A. bowersii*, from 58° N to about 30° S; and *N. larseni*, from 47° to 17° N), while the other three (*A. infans*; *N. curvirostris;* and *N. scolopaceus*) are circumglobal (Fishbase 2015; Smith & Nielsen 1989; Charter 1996).

To the authors' best knowledge, since Garman (1899) and Nielsen & Smith's (1978) papers, which two species (*A. bowersii* and *N. fronto* Garman, 1899, now synonym of *N. scolopaceus* (Catalog of Fishes 2015; Smith & Nielsen 1989), in Garman (1899); and *A. bowersii* and *N. scolopaceus* in Nielsen & Smith (1978)) were listed from the Gulf of Panama and contiguous waters, there are no recent published records of snipe eels from the Pacific coast of Lower Central America (Costa Rica and Panama). Notably, to date, none of these species have been formally listed

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among the Costa Rican Pacific ichthyofauna (Bussing & López 1994; Bussing & López 2009; Bussing & López 2011).

Between 1972 and 1973, during the field campaigns of the research vessels (R/V) Searcher and Velero IV (Cortés 2009), several specimens identified as "Nemichthyidae" were captured from the Pacific coasts of Costa Rica and Panama (between 9°30′ and 4°34′ N). This material, deposited at the fish collection of the Museo de Zoología of the Universidad de Costa Rica (UCR), was recently revised and two species were identified: *A. bowersii* and *N. scolopaceus*. In this contribution, these new records are formally reported; comparative morphometric data and distributional information are proportioned and discussed. In addition, a key to the identification of the eastern Pacific species of the family is presented.

Results and discussion

Systematics

Genus *Avocettina* Jordan & Davis, 1891

Avocettina bowersii (Garman, 1899)

(Table 1, Figs. 1a–b, and 2a–b)

Material examined

Twenty-eight specimens, 197–628 mm total length (TL): UCR 2676-002, *n* = 1, 402 mm TL, near Isla del Caño, Costa Rica, 8°20′5″N, 83°16′39″W, 295–350 m, 20 July 2004; UCR Searcher 493, *n* = 3, 241–433 mm TL, 41 km SW Isla del Caño, Costa Rica, 8°17′4″N, 84°7′48″W, 700 m, 22 March 1972, W.B. Bussing, M.M. Murillo et al.; UCR Searcher 494, *n* = 3, 328–473 mm TL, 42 km SW Isla del Caño, Costa Rica, 8°18′0″N, 84°6′44″W, 400 m, 22 March 1972, W.B. Bussing, M.M. Murillo et al.; UCR Searcher 504, *n* = 1, 443 mm TL, SW of Gulf of Nicoya, Costa Rica, 8°29′24″N, 85°11′23″W, 830 m, 7 March 1972, W.B. Bussing, M.M. Murillo et al.; UCR Velero-IV 19060, *n* = 1, 345 mm TL, 30.0 miles, 195° T from Punta Burica, Costa Rica, 7°17′26″N, 83°1′48″W, 400 m, 14 June 1973, R/V Velero IV; UCR Velero-IV 19070, *n* = 2, 321–354 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°12′35″N, 83°2′59″W, 300 m, 14 June 1973, R/V Velero IV; UCR Velero-IV 19072, *n* = 3, 417–485 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°10′12″N, 83°4′12″W, 500 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19073, *n* = 2, 347–407 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°7′20″N, 83°4′22″W, 1000 m, 15 June 1973, R/V Velero IV; Velero-IV 19076, *n* = 1, 628 mm TL, Eastern Tropical Pacific, off Panama, Panama, 6°31′56″ N, 82°33′36″W, 500 m, 15 June 1973, R/V Velero IV; UCR UCR Velero-IV 19077, *n* = 2, 298–446 mm TL, Eastern Tropical Pacific, off Panama, Panama, 6°29′32″ N, 82°33′42″W, 600 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19078, *n* = 3, 302–476 mm TL, Eastern Tropical Pacific, off Panama, Panama, 6°25′56″N, 82° 33′36″W, 800 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19088, *n* = 1, 384 mm TL, Eastern Tropical Pacific, off Panama, Panama, 5°22′12″N, 82°21′13″W, 500 m, 17 June 1973, R/V Velero IV; UCR Velero-IV 19090, *n* = 1, 207 mm TL, Out of radar contact with land, 5°17′34″N, 82°19′48″W, 800 m, 17 June 1973, R/V Velero IV; UCR Velero-IV 19121, *n* = 2, 361–452 mm TL, Out of radar contact with land, Panama, 5°0′0″N, 82°17′59″W, 500 m, 21 June 1973, R/V Velero IV; UCR Velero-IV 19125, *n* = 1, 197 mm TL, Out of radar contact with land, Panama, 5°16′48″N, 82°5′59″W, 800 m, 21 June 1973, R/V Velero IV; UCR Velero-IV 19126, *n* = 1, 344 mm TL, Out of radar contact with land, Panama, 5°19′12″N, 82°1′48″W, 1000 m, 21 June 1973, R/V Velero IV.

Description

Morphometric measurements are presented in Table 1. Body long and slightly compressed. Mouth extremely long and pointed beak-like (except in a fully mature male). Maxilla with a small knob at the tip. Upper jaw

Table 1 Morphometric data of *Avocettina bowersii* from Costa Rica and Panama

Measurements	Females and immature males (*n* = 27)	Mature male (*n* = 1)
MBD/SL (%)	1.68–3.04	2.52
HL/SL (%)	7.76–12.89	6.98
Sn-L/HL (%)	56.22–76.51	22.22
Sn-D/SL (%)	9.17–15.31	8.03
Sn-Pec/SL (%)	8.00–13.28	7.75
Sn-A/SL (%)	12.20–28.94	17.36
ID/HL (%)	2.24–5.48	8.33
ED/HL (%)	3.97–10.61	13.09
SL (mm)	197–628	361

Acronyms are as follow: *MBD* maximum body depth, *HL* head length, *Sn-L* snout length, *Sn-D* snout to first dorsal fin length, *Sn-pec* snout to pectoral fin length, *Sn-A* snout to anal fin length, *ID* interorbital distance, *ED* eye diameter, *SL* standart length

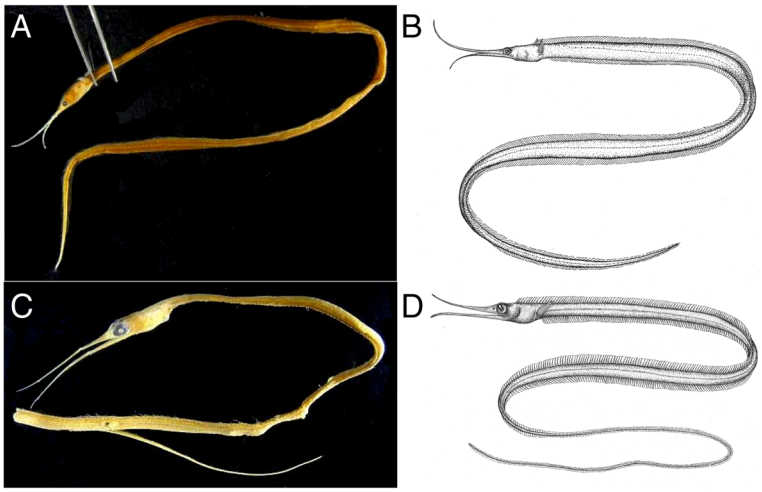

Fig. 1 **a**–**b**: *Avocettina bowersii*; **a** Preserved specimen (UCR 2676–002, 315 mm TL); **b** Drawing (UCR Velero-IV 19076, 628 mm TL). **c**–**d** *Nemichthys scolopaceus*; **c** Preserved specimen (UCR 0425–007, 397 mm TL); **d** Drawing (UCR Velero-IV 19122, 836 mm TL)

longer than lower. Teeth numerous, small, close-set, recurved, distributed in diagonal rows. Eye small to medium sized, its diameter usually less tan 50 % of head depth. Supraorbital pores 5–6, suborbital pores 5–7, postorbital pores 2–4, preopercular pores 2. Posterior part of head, from eye to gill opening, usually narrower than rest of body; maximum body depth towards their posterior half. Lateral-line pores arranged in a single row. Pectoral fin-rays 15–17. Dorsal fin long, with well-developed spine-like rays, originating above (male) or behind (females and inmature males) pectoral fins. Anus located far forward, behind pectoral fins. Anal fin higher

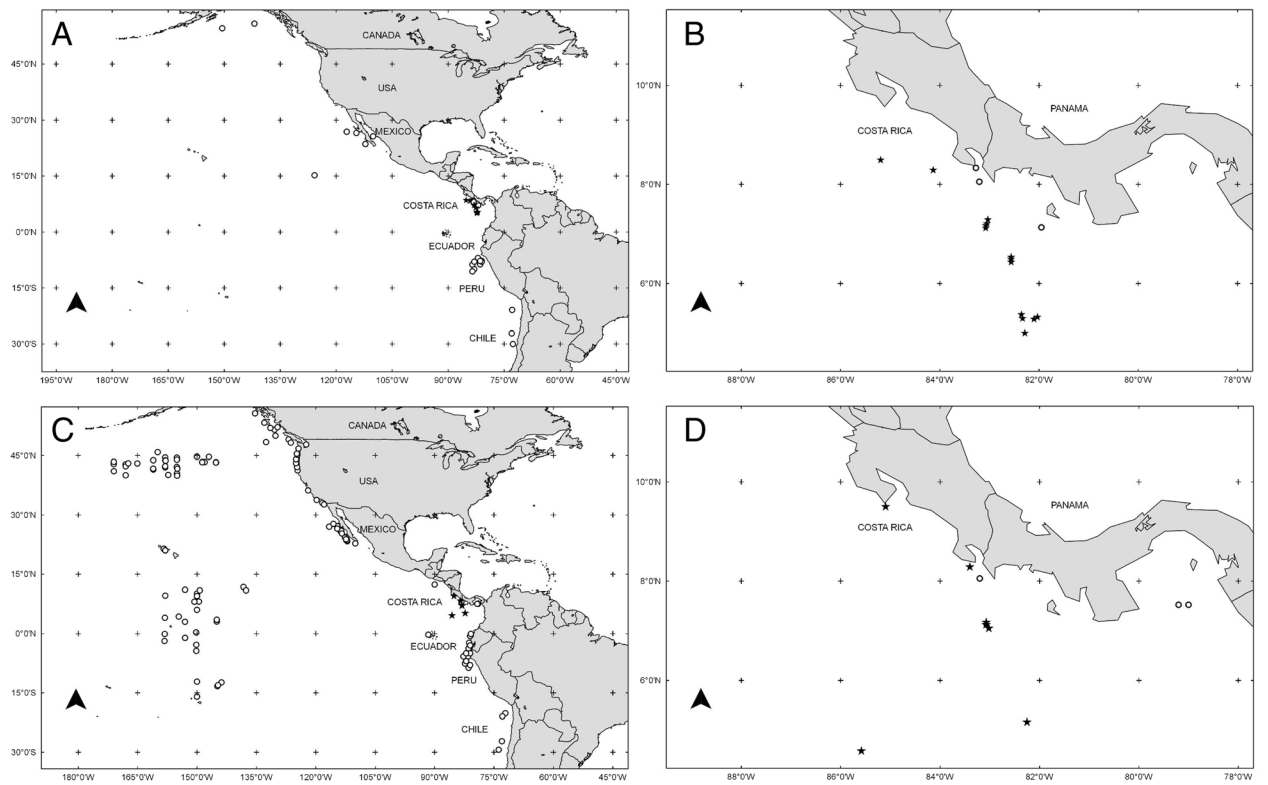

Fig. 2 Records of *Avocettina bowersii* (**a**–**b**) and *Nemichthys scolopaceus* (**c**–**d**) in the Eastern Pacific Ocean; **a** and **c** Whole area; **b** and **d** Lower Central America. Stars = present records; circles = previous literature and museum records

than dorsal fin. Caudal fin not ending in a long filament. Larger specimens tan to dark brown overlain with fine dark speckling; smaller specimens brownish-grey.

The data from the specimens herein described are in agreement with the size, body proportions and counts reported by other authors (Garman 1899; Nielsen & Smith 1978) who systematically described this species.

Remarks

Avocettina bowersii is an oceanic species, which has been collected from the surface to depths up to 4000 m (Garman 1899; Wheeler 1969). It is found in the eastern Pacific Ocean from California, United States of America (USA), to central Chile (Catalog of Fishes 2015; Pequeño 1989; Charter 1996; McCosker 2009) (Fig. 2a and b). The present report constitutes, on the basis of Nielsen & Smith (1978), the second documented record of the species in the Pacific coast of Costa Rica, and, after Garman (1899) and Nielsen & Smith (1978) papers, the third documented record of the species in the Pacific coast of Panama.

Systematics

Genus *Nemichthys* Richardson, 1848

Nemichthys scolopaceus Richardson, 1848

(Table 2, Figs. 1c–d, and 2c–d)

Material examined

Seventeen specimens, 192–893 mm TL: UCR 0425-007, $n = 1$, 397 mm TL, Between Cabo Blanco and Punta Herradura, Costa Rica, 18 May 1970, M. Gauthier; UCR 2290-005, $n = 1$, 893 mm TL, In front of Cabo Blanco, Costa Rica, 9°30′0″N, 85°5′39″W, September 1992, W. Valdelomar; UCR Searcher 501, $n = 2$, 457–762 mm TL, 20 Km S península de Osa, Costa Rica (8°16′59″ N, 83° 23′59″ W), 950 m, 21 March 1972, W.B. Bussing, M.M. Murillo et al.; UCR Velero-IV 19053, $n = 1$, 192 mm TL, 31.3 miles, 178° T from Isla del Coco, Costa Rica, 4°34′48″N, 85°34′58″W, 500 m, 5 June 1973, R/V Velero IV; UCR Velero-IV 19072, $n = 3$, 295–606 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°10′12″N, 83°4′12″W, 500 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19073, $n = 2$, 194–240 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°7′20″N, 83°4′22″W, 1000 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19074, $n = 3$, 192–378 mm TL, Eastern Tropical Pacific, off Panama, Panama, 7°2′59″N, 83°1′12″W, 300 m, 15 June 1973, R/V Velero IV; UCR Velero-IV 19122, $n = 3$, 382–836 mm TL, Out of radar contact with land, Panama, 5°9′36″N, 82°15′0″W, 750 m, 21 June 1973, R/V Velero IV; UCR 2676-002, $n = 1$, 517 mm TL, near Isla del Caño, Costa Rica, 8°20′5″N, 83°16′39″W, 295–350 m, 20 July 2004.

Description

Morphometric measurements are presented in Table 2. Body long and slightly compressed. Mouth extremely long and pointed beak-like (except in a fully mature male). Maxilla without a small knob at the tip. Upper jaw longer than lower. Teeth numerous, small, close-set, slightly recurved backwards, distributed in diagonal rows. Eye relatively large, its diameter about 50 % of head depth. Supraorbital pores 9–11, suborbital pores 12–15, postorbital pores 7–10, preopercular pores 5–6. Posterior part of head, from eye to gill opening, usually deeper than rest of body. Lateral-line pores arranged in three longitudinal rows, the upper and lower forming a square with the median between and slightly below the midline. Pectoral fin-rays 10–13. Dorsal fin long, with well-developed spine-like rays, tapering toward the tail, originating about 66 % the distance between posterior edge of eye and pectoral fin. Anus located beneath pectoral fins base. Anal fin higher than dorsal fin. Caudal fin ending in a long filament. Larger specimens dark brown-grey with light grey belly; smaller specimens brownish-grey with light beige belly.

Table 2 Morphometric data of *Nemichthys scolopaceus* from Lower Central America (This study) and comparative data

Measurements	Puget Sound, USA (Jordan & Gilbert 1881)	Strait of Messina, Italy (Genovese 1954)	Aegen Sea, Turkey (Bilecenoglu et al. 2006)	Lower Central America	
				Females and immature males ($n = 16$)	Mature male ($n = 1$)
MBD/SL (%)	1.54	0.69	0.98–1.68	0.77–2.18	2.03
HL/SL (%)	9.81	6.79	9.11–9.15	5.55–14.58	7.32
Sn-L/HL (%)	80.95	68.11	64.64–66.67	50.42–70.31	19.16
Sn-D/SL (%	–	6.60	3.27	6.10–12.73	4.64
Sn-Pec/SL (%)	–	7.19	4.10	7.96–15.36	8.39
Sn-A/SL (%)	–	7.98	4.97	8.17–16.04	9.15
ID/HL (%)	–	6.52	4.53	2.40–5.47	10.31
ED/HL (%)	8.57	7.24	8.27–10.83	4.92–8.60	15.72
SL (mm)	543.5	1015	820.5–974.0	192–893	556

Acronyms are listed in Table 1. Unavailable measurements are represented with an en-dash (–)

The data from the specimens herein described are in agreement with the size, body proportions and counts reported by other authors (Garman 1899; Nielsen & Smith 1978; Jordan & Gilbert 1881; Genovese 1954; Bilecenoglu et al. 2006; Filiz et al. 2007) who systematically described this species.

Remarks

Nemichthys scolopaceus is an oceanic species, which has been collected from the surface down to depths of 2500 m (Fishbase 2015); Charter 1996). It is found in the eastern Pacific Ocean from Alaska, United States of America (USA), to Central Chile (Fishbase 2015); Nielsen & Smith 1978; Pequeño 1989; McCosker 2009) (Fig. 2c and d). The present record constitutes, on the basis of Nielsen & Smith (1978) and Bussing & López (1994; 2009; 2011), the first documented record of the species in the Pacific coast of Costa Rica, and, after Garman (1899) and Nielsen & Smith (1978), the third documented record of the species in the Pacific coast of Panama.

Key to eastern Pacific species of the family Nemichthyidae

The following key is based on our research and data available in the literature (Garman 1899; Nielsen & Smith 1978; Charter 1996; McCosker 2009)

1a Lateral-line pores arranged in a single row; anus posterior to pectoral fins; precaudal vertebrae 59–72; caudal region attenuate (see Fig. 1a–b) … 2

1b Lateral-line pores arranged in three longitudinal rows, with five pores per segment forming a square or a rectangle; anus below pectoral fins; precaudal vertebrae 79–105; caudal region filiform (see Fig. 1c–d) … 3

2a Eye small to medium sized, its diameter 18–29 %, usually around 22 %, of postorbital length; predorsal pores 6–11, usually 9; predorsal length 32–48 %, usually around 38 %, of preanal length; precaudal vertebrae usually 59–66 (from California, USA, to Central Chile)… *Avocettina bowersii*

2b Eye medium sized to large, its diameter 24–47 %, usually around 35 %, of postorbital length; predorsal pores 5–8, usually 6; predorsal length 21–39 %, usually around 30 %, of preanal length; precaudal vertebrae usually 69–72 (from Queen Charlotte Islands and British Columbia, Canada to central Mexico, including the Gulf of California)… *Avocettina infans*

3a Postorbital pores 12–23; preopercular pores 8–17; lateral line pores form a rectangle shorter than high (from Oregon, USA, to central Mexico, including the Gulf of California)… *Nemichthys larseni*

3b Postorbital pores 3–14; preopercular pores 2–8; lateral line pores form a square or a rectangle longer than high … 4

4a Body pale with large melanophores scattered along the ventral surface, usually concentrated around stomach; dorsal and anal fins edged in black posteriorly on the caudal filament; subcutaneous dark bars between vertebrae presents (from Central Chile, rare)… *Nemichthys curvirostris*

4b Body uniformly dark or countershaded, more or less pigmented; dorsal and anal fins not edged in black posteriorly on the caudal filament; subcutaneous dark bars between vertebrae absents (from Alaska, USA, to Central Chile)… *Nemichthys scolopaceus*

Conclusions

Avocettina bowersii and *Nemichthys scolopaceus* are herein formally reported from the Pacific coast of Costa Rica and Panama. These findings increase the knowledge on the Central American marine ichthyofauna and provide evidence of a broader distributional pattern for these species in the eastern Pacific region.

Methods

Counts and measurements (Tables 1 and 2) were taken on the left side of the specimens Genovese (1954) and Nielsen & Smith (1978). Measurements were made using calipers to the nearest tenth millimeter (mm) or measuring tape to the nearest mm. Comparative information was obtained from the literature (Nielsen & Smith 1978; Smith & Nielsen 1989; Jordan & Gilbert 1881; Genovese 1954; Bilecenoglu et al. 2006; Filiz et al. 2007). Maps were made using QUANTUM GIS 2.0. Distributional data information was obtained from the literature (Garman 1899; Nielsen & Smith 1978; Pequeño 1989; Bilecenoglu et al. 2006; Chirichigno & Vélez 1998) and from the Ocean Biogeographic Information System (OBIS) online database (Ocean Biogeographic Information System 2015).

Abbreviations

CIMAR: Centro de Investigación en Ciencias del Mar y Limnología; ED: eye diameter; HL: head length; ID: interorbital distance; MBD: maximum body depth; R/V: research vessel; SL: standart length; Sn-A: snout to anal fin length; Sn-D: snout to first dorsal fin length; Sn-L: snout length; Sn-pec: snout to pectoral fin length; TL: total length; UCR: Universidad de Costa Rica; USA: United States of America.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

OlCM carried out the measurements of the specimens and drafted the manuscript. AA conceived of the study, and participated in its design and coordination and helped to draft the manuscript. Both authors read and approved the final manuscript.

Authors' information

OlCM is a master student at the Universidad Nacional de Costa Rica, Heredia, Costa Rica. To complete their grade studies, he participated, in collaboration with the second author, in a short-term lab work at the UCR, which derived in this publication.

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