

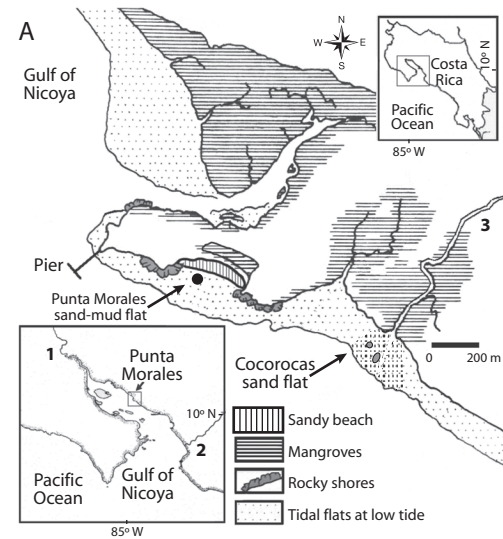


Fig. 1. A. Location of the Punta Morales and Cocorocas intertidal flats. Punta Morales Peninsula, mid upper Gulf of Nicoya estuary. Pacific, Costa Rica. (10°N-85°W). 1. Tempisque River, 2. Tárcoles River, 3. Lagarto River. **B.** Sand mud flat. **C.** Sand flat. Two islets (outlined in A) are visible in the background. Note horizontal dark band marking high tide level on the tree islet.

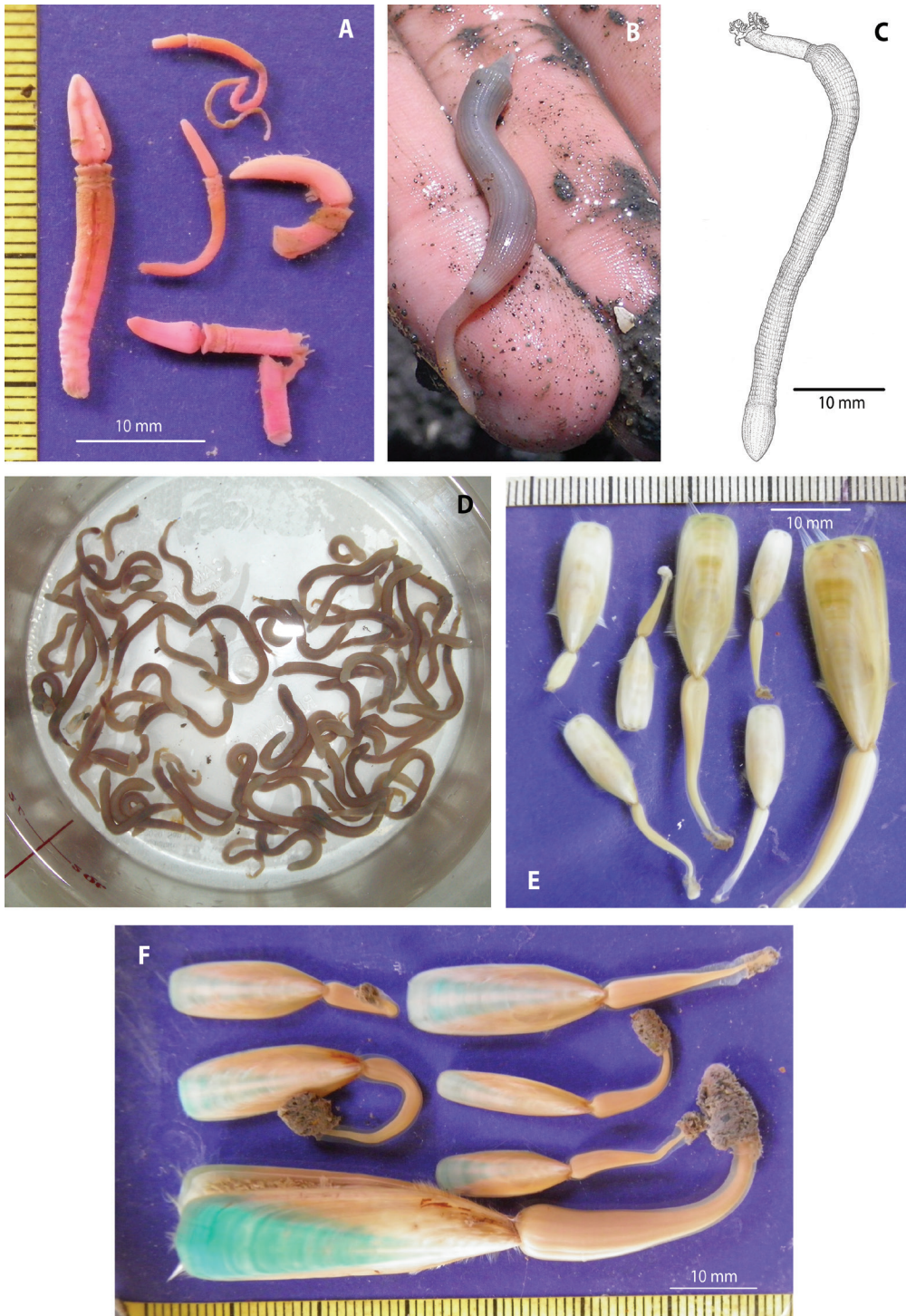
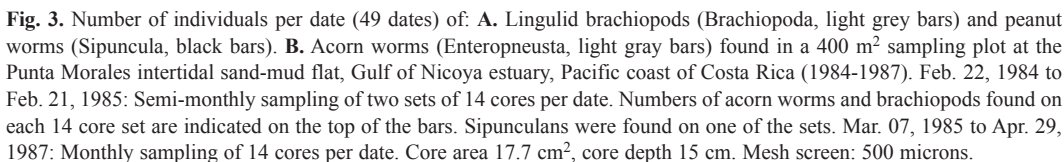


Fig. 2. **A.** Anterior regions (proboscis, collar, and part of trunk) of five Rose Bengal stained acorn worms. **B.** Live *Sipunculus nudus* collected at the sand flat. **C.** *S. nudus* drawn from live specimen. **E.** *S. nudus* during the 72 h depuration process. **D.** *G. albida*. Note setae bundles. **E.** Rose Bengal stained *Glottidia audebarti*. Note pedicles end with agglomerated sand grains.



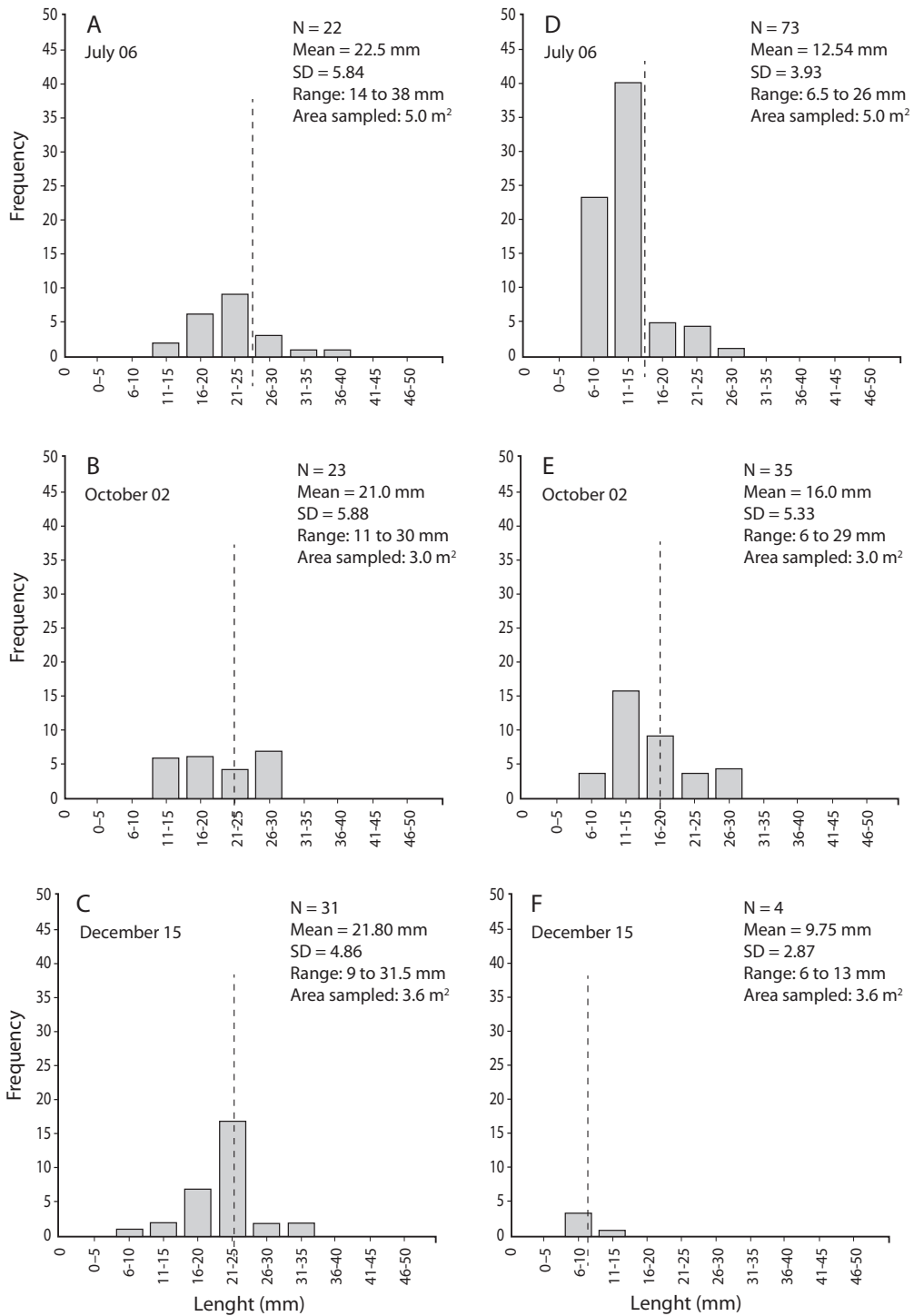


Fig. 4. Arbitrary shell length groups (mm) of brachiopods: **A, B, C.** *Glottidia audebarti*. **D, E, F.** *G. albida*. Specimens collected on July 2 (early rainy season), October 6 (mid rainy season), and December 15 (dry season) 2015. Cocorocas sand flat, Gulf of Nicoya estuary, Pacific, Costa Rica. Vertical dashed lines = mean length of individuals.

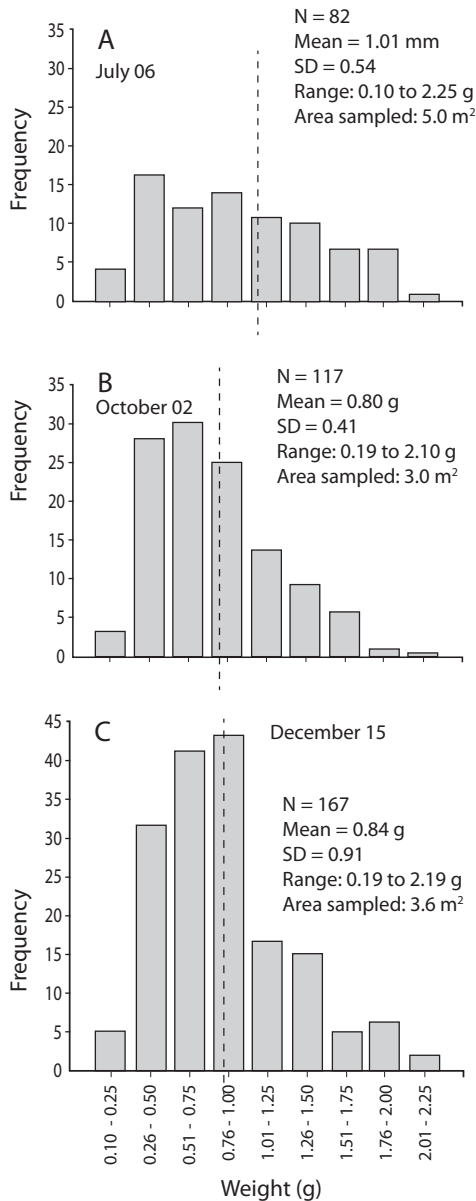


Fig. 5. Arbitrary weight (grams) groups for the sipunculan *Sipunculus nudus*: **A.** July 2 (early rainy season), **B.** October 2 (mid rainy season), **C.** December 15 (dry season), 2015. Cocorocas sand flat, Gulf of Nicoya estuary, Pacific, Costa Rica. Vertical dashed line = mean weight of individuals.

TABLE 1

Mean percentages of dry sediment fractions retained on sieves. Lower size (microns) limit of particles: Granules (2000), coarse+very coarse sands (1000), medium sand (500), fine sand (250), very fine sand (63). Silt+clay: fraction washed thru a 63 micron mesh sieve. Percent organic matter content (by combustion at 450oC). **A.** Punta Morales sand-mud flat (1984, n=10). **B.** Cocorocas sand flat (2015, n=3). Gulf of Nicoya estuary, Pacific coast of Costa Rica

	Granules	Coarse+Very coarse	Medium	Fine	Very fine	Silt+clay	Organics	Total
A.	0.7	0.8	3.3	46.4	15.1	31.5	2.0	99.8
B.	3.7	10.7	9.1	29.2	41.7	5.6	3.0	100

TABLE 2

Mean (n = 4) metal concentrations (+/- Standard Deviation) in non-depurated whole *Sipunculus nudus* (Sipuncula), in tissues and shells of *Glottidia audebarti* (Brachiopoda), and in sediments. Unpublished data from Vargas, J.A. & M.I. Abdullah, 1996, AAS (Atomic Adsorption Spectrometry, Dept. of Biology, University of Oslo, Norway). Cocorocas intertidal sand flat. Gulf of Nicoya estuary, Pacific, Costa Rica. March, 1996.

Concentrations in µg/g dw, except for iron (mg/g dw)

Species / metal	Fe	Cr	Zn	Pb	Cu	Cd
<i>S. nudus</i> , whole	5.4 ± 0.7	11 ± 5.0	56 ± 2.0	9.3 ± 0.2	26 ± 2.0	1.2 ± 0.5
<i>G. audebarti</i> , soft parts	1.60 ± 0.07	1.5 ± 0.1	123.5 ± 7.5	239 ± 0.65	7.9 ± 0.2	5.20 ± 0.15
<i>G. audebarti</i> , pedicles	0.48 ± 0.01	2.1 ± 0.1	42.6 ± 0.1	2.4 ± 0.1	31.4 ± 0.2	0.37 ± 0.02
<i>G. audebarti</i> , shells	0.57 ± 0.07	4.7 ± 0.8	73.7 ± 0.1	21.0 ± 0.6	12.88 ± 0.01	3.86 ± 0.01
Sediments	25.8 ± 5.3	31.5 ± 0.5	62.6 ± 0.5	21.1 ± 0.2	36.2 ± 0.2	1.10 ± 0.02
Blanks	<0.04	<0.02	0.06	<0.05	<0.02	<0.01

TABLE 3

A. Metal concentrations in whole soft tissues of the deposit feeder *Sipunculus nudus* (Sipuncula).
B. Length of body (mm) and weight (g) of blotted-dry live non-depurated, and after 72 hour depuration of individuals of *S. nudus* (n = 42). **C.** Metal concentrations in sediments. All concentrations in µg/g dw except for iron (mg/g dw).
 Cocorocas sand flat, Gulf of Nicoya estuary, Pacific coast of Costa Rica. March 8, 2000

A

Depurative Treatment	Statistics		Fe	Mn	Ni	Zn	Pb	Cu	Cd
No	Range	Min.	16.1	34.4	1.17	8.44	0.60	6.42	0.17
		Max.	22.5	234.6	15.57	144.0	4.67	29.1	1.64
	Mean		19.4	165	10.4	81	2.8	20.7	0.63
	S.D.		3.4	113	8.0	53	1.5	9.9	0.61
	n		5	3	3	5	5	4	5
	Median		16.9	226.0	14.5	76.7	2.95	23.6	0.53
Yes	Range	Min.	1.55	1.23	0.15	5.55	0.23	1.86	0.06
		Max.	9.21	105.7	12.75	61.1	6.39	52.7	1.00
	Mean		6.2	61	8.4	39	2.7	24	0.62
	S.D.		3.3	54	7.1	23	2.3	21	0.32
	n		5	3	3	5	5	4	5
	Median		6.52	77.4	12.2	43.9	2.59	21.3	0.65

B

	Non depurated		Depurated	
	Length	Weight	Length	Weight
Mean	45.1	0.955	45.0	0.840
S.D.	8.28	0.260	5.02	0.160
Min	30.0	0.650	32.0	0.611
Max	65.0	1.670	60.0	1.352
Median	45.5	0.965	45.0	0.824

Mann-Whitney U test for equal weight medians: 571 (p = 0.01) significant.

Mann-Whitney U test for equal length medians: 807 (p = 0.76) non significant.

C

Statistics		Fe	Mn	Ni	Zn	Pb
Range	Min.	20.9	203.8	7.14	30.2	5.45
	Max.	60.3	549.3	20.6	83.1	12.6
Mean (n = 4)		46	413	16.1	63	10.1
S.D.		17	148	6.1	23	3.2
Median		50.4	449.2	18.3	69.9	11.1

S.D. = standard deviation. n = number of samples.

TABLE 4

Summary data of maximum concentrations (ug/g dw), except Fe (mg/g dw) of metals included in Tables 2 & 3. *Sipunculus nudus*, *Glottidia audebari*, and sediments. Cocorocas sand flat, Gulf of Nicoya estuary, Pacific, Costa Rica. 1996 & 2000

	Fe	Cr	Zn	Pb	Cu	Cd	Mn	Ni
Soft parts	22.5	10.8	144.0	9.3	52.7	5.2*	234.6	15.5
Shells	0.5	4.7	73.7	21.0	12.8	3.8	ND	ND
<i>T. affinis</i> **	216.0	21.6	206.7	1.3	21.6	0.7	255.2	4.1
Sediments	60.3	31.5	83.1	21.1	36.2	1.1	549.3	20.6

**Glottidia audebari*. Other concentrations in soft parts are for *S. nudus*.

***Tagelus affinis*, razor clam from the Cocorocas sand flat. Non-depurated soft parts. Data from Vargas, Acuña-González, Gómez & Molina (2015).

ND = No Data.

TABLE 5

Distribution of organisms among sampling units for the date with the maximum number of individuals (see Figs. 3, 4, 5). Total number and date. Estimated mean density (ind./m²). A. Punta Morales (Corer: 17.7 cm²) B. Cocorocas (Wooden frame: 2000 cm²). Intertidal flats, Gulf of Nicoya estuary, Pacific, Costa Rica

	Distribution, (total number, date), mean density / m ²																				Ind. / m ²	
A. 1984-1987																						
Enteropneusta	1	0	0	0	0	2	1	0	3	0	0	5	2	0	-	-	-	-	-	-	(n = 14, Dec. 26, 1984)	40
<i>Glottidia</i> spp.	0	0	1	0	0	0	2	0	1	0	3	1	2	0	-	-	-	-	-	-	(n=10, Oct. 10, 1984)	29
<i>Sipunculus nudus</i>	0	1	0	0	1	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	(n = 2, Jan. 10, 1985)	5.7
B. 2015																						
<i>G. audearti</i>	0	4	2	0	11	2	3	1	1	1	2	0	0	1	2	0	1	0	-	-	(n = 31, Dec. 15)	8.6
<i>G. albida</i>	2	1	1	0	0	10	15	1	1	0	0	2	1	18	1	0	0	5	6	9	(n = 73, Jul. 6)	20.3
<i>S. nudus</i>	5	11	20	13	3	16	9	13	10	2	11	11	8	7	4	4	13	7	-	-	(n = 167, Dec. 15)	46.4