

NOTES ON SOME CHAETOGNATHS FROM PINE CAY, TURKS AND CAICOS ISLANDS (BRITISH WEST INDIES)

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ABSTRACT Seven species of planktonic Chaetognatha — *Ferosagitta hispida*, *Flaccisagitta enflata*, *F. hexaptera*, *Krohnitta pacifica*, *Sagitta bipunctata*, *Serratosagitta serratodentata*, and *Pterosagitta draco* — were present in plankton samples collected in waters north of Pine Cay, Turks and Caicos Islands, British West Indies. In addition, the epibenthic species *Spadella cephaloptera*, *Paraspadella nana*, and *P. schizoptera* were present, the latter two species associated mainly with shallow clumps of the coralline alga, *Neogoniolithon* sp., and with sponge-algal communities. One specimen of *S. cephaloptera* was collected at 35 m from a sand bottom north of the fringing reef adjacent to Pine Cay. Meristic data for *F. hispida* and for the three epibenthic species are provided.

INTRODUCTION

Water surrounding small islands in the British West Indies is primarily oceanic in nature, with little dilution from terrestrial freshwater sources. Consequently, the near-shore plankton community is composed largely of species associated with oceanic currents.

Detailed information on the chaetognath population structure in the southern Bahamas and British West Indies is sketchy. Investigations of planktonic chaetognath distribution in the tropical western Atlantic were published by Ritter-Záhony (1910), Suárez-Caabro (1955), Colman (1959), Alvaríño (1969), and more recently Michel *et al* (1976). Distribution of the epibenthic family Spadellidae in the Bahamas was discussed by Owre (1972), who also mentioned four planktonic chaetognath species from surface qualitative samples collected at diverse stations among the islands. Michel (1984), in a synopsis of chaetognaths of the Caribbean Sea and adjacent waters, provided an identification key and illustrations of species occurring in the region. The purpose of this paper is to document three epibenthic species occurring at Pine Cay and planktonic species from nearby waters.

MATERIALS AND METHODS

Chaetognaths from near-shore waters in the vicinity of Pine Cay (Figure 1) were examined from collections made in April 1988, November 1988, and April 1989. Several methods were used for collecting planktonic

specimens (Table 1), including towing a 0.5 m, 500 µm mesh net from a skiff, pulling an Ockelmann epibenthic dredge (sled) both from a skiff and along the beach by hand, and using an illuminated plexiglass plankton trap at night. Epibenthic specimens were collected by gently hand washing substrata (e.g., algae clumps, sponges) in a weak formalin-seawater solution. Attached animals that became dislodged were captured on a 0.5 mm sieve. Epibenthic specimens were also collected using a hand-operated PVC yabby pump and sock-net of 0.5 mm mesh size. Samples were fixed in 10% formalin-seawater. Chaetognaths removed from the samples were identified to species, counted, and assigned to a stage of maturity based on the four stages of gonadal development reviewed by Alvaríño (1965). Total numbers and maturity stages of chaetognaths sorted from the plankton samples are presented in Table 2. Numbers and stages of maturity of chaetognaths from the various epibenthic collections are presented in Table 3; some meristic values are provided in Table 4.

RESULTS AND DISCUSSION

Planktonic species (Table 2)

With the exception of the primarily neritic *Ferosagitta hispida* collected only in epibenthic samples (Table 1), the planktonic species are all oceanic and found in the epipelagic strata. However, *Flaccisagitta hexaptera*, considered rare in surface waters, is most often associated with the lower euphotic zone from about 50 to 200 m. All are cosmopolitan except *Serratosagitta serratodentata* and *Ferosagitta hispida*, which are tropical Atlantic species (Pierrot-Bults 1974; Alvaríño 1965). Illustra-

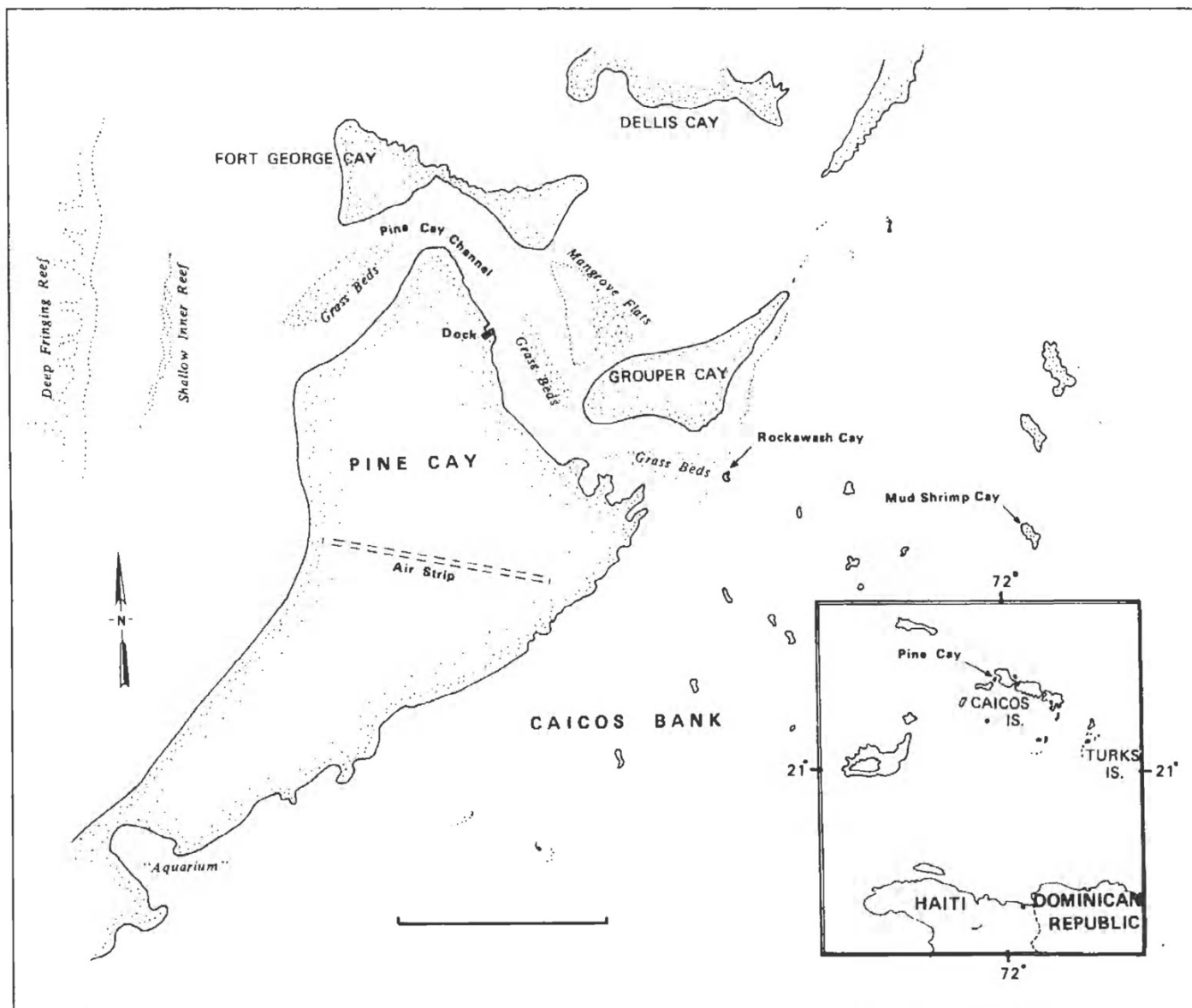


Figure 1. Map showing locations of collecting sites in the vicinity of Pine Cay, Turks and Caicos Islands, British West Indies. Scale = 1 km.

tions and descriptions were published by Alvarifio (1969), Michel (1984), and McLelland (1989). The following list presents synonyms and ecological notes for the seven planktonic species:

***Ferosagitta hispida* (Conant, 1895)**

Sagitta hispida, Conant 1895

Sagitta glorieae, Almeida-Prado 1960

Parasagitta hispida, Tokioka 1965

Ferosagitta hispida, Kassatkina 1971

Ecology and distribution: This species is common in neritic, tropical and subtropical waters near continents and islands of the Atlantic ocean (Boltovskoy 1981; Michel 1984). It was very abundant in the nearshore

waters around Pine Cay, especially over the grass beds in the channel (Ockelmann dredge collections), but absent in surface net collections made over the fringing reef in April 1988. A near-bottom distribution was also noted for the species by Owre (1972) from Bahamian collections and supports the idea of Robert Bieri (pers. comm. 1989) that *F. hispida* might be considered "quasi-planktonic;" that is, spending some of its time attached or associated with substrata such as blades of the sea grass *Thalassia*.

***Flaccisagitta enflata* (Grassi, 1881)**

Sagitta Enflata (sic), Grassi 1881

Sagitta flaccida, Conant 1896

TABLE 1

Benthic and epibenthic collection data from various sites around Pine Cay.

collection	location	date	time	approx. depth (m)	substrate	method	Total Specimen
A	Mud Shrimp Cay	4/8/88	—	1	<i>Neogoniolithon</i>	formalin wash	12
B	Rock-a-wash Cay	10/30/88	--	1	gray sponge	formalin wash	7
C	Pine Cay dock	11/2/88	2000	2	silt	dredge	2
D	NE grass beds	11/2/88	--	2	<i>Thalassia</i>	dredge	111
E	North beach	11/9/88	--	3	sand	dredge	33
F	NE grass beds	11/10/88	--	2	<i>Thalassia</i>	dredge	32
G	Fringing reef	11/4/88	--	35	sand	hand net	1
H	Fringing reef	11/5/88	--	4	rubble	yabby pump	10
I	Ft. George Cay	11/8/88	--	1	<i>Neogoniolithon</i>	formalin wash	5
J	Ft. George Cay	11/8/88	--	1	soft algae	formalin wash	25
K	NE grass beds	4/7/89	1830	2	<i>Thalassia</i>	dredge	5
L	Fringing reef	4/9/89	--	4.5	rubble	yabby pump	15
M	Ft. George Cay	4/10/89	1700	1	<i>Neogoniolithon</i>	formalin wash	1
N	NE grass beds	4/11/89	1400	3	<i>Thalassia</i>	dredge	2
O	Fringing reef	4/12/89	1100	10	sand	yabby pump	3
P	Aquarium	4/12/89	2200	0.5	silt	light trap	5
Q	North beach	4/12/89	2215	0.5	sand	dredge	1
R	Rock-a-wash Cay	4/13/89	1400	1	<i>Neogoniolithon</i>	formalin wash	27
S	Rock-a-wash Cay	4/13/89	1400	1	sponge	formalin wash	48
T	NE beach	4/14/89	--	10	grass-algae	dredge	5
U	North beach	4/14/89	1800	4	sand	dredge	11
V	North beach	4/14/89	--	15	sand-grass	dredge	50
W	Fringing reef	4/16/89	0900	4	rubble	yabby pump	67

Sagitta gardineri, Doncaster 1903*Sagitta brachycephala*, Moltschanoff 1907*Sagitta inflata*, Ritter-Záhony 1908*Sagitta australis*, Johnston 1909*Flaccisagitta enflata*, Tokioka 1965

Ecology and distribution: *Flaccisagitta enflata*, a very common species in oceanic and coastal waters, is epipelagic in tropical and temperate regions throughout the world (Alvario 1965; Boltovskoy 1981). It was the most abundant chaetognath in surface tow collections from Pine Cay made in April 1988.

Flaccisagitta hexaptera (d'Orbigny, 1843)*Sagitta hexaptera* d'Orbigny, 1843*Sagitta magna*, Langerhans 1880*Sagitta longidentata*, Grassi 1881*Sagitta hexaptera* f. *magna*, Germain and Joubin 1916*Flaccisagitta hexaptera*, Tokioka 1965

Ecology and distribution: *Flaccisagitta hexaptera*, an oceanic, epipelagic species in tropical and temperate regions (Alvario 1965), occurs in the deeper epipelagic to upper mesopelagic zones (100-500 m) in warm seas (Owre 1960; David 1963). The single specimen collected

was not expected in our samples, because the species is seldom found in shallow coastal waters.

Krohnitta pacifica (Aida, 1897)*Krohnitta pacifica*, Aida 1897*Krohnitta subtilis* (partim), Ritter-Záhony 1910*Krohnitta kerberti*, Oye 1918*Eukrohnitta pacifica*, Michael 1911*Krohnitta mutabii*, Alvario 1969*Krohnitta pacifica*, Tokioka 1939

Ecology and Distribution: *Krohnitta pacifica*, a semi-neritic, epipelagic species, is known from tropical and subtropical seas (Furnestin 1966; Boltovskoy 1981). It is common along oceanic-coastal water fronts (Pierce and Wass 1962; Almeida-Prado 1968; McLelland, 1984).

Pterosagitta draco (Krohn, 1853) Ritter-Záhony, 1911*Sagitta draco*, Krohn 1853*Pterosagitta mediterranea*, Costa 1869*Spadella draco*, Langerhans 1880*Pterosagitta besnardi*, Vannucci and

Hosoe 1952

TABLE 2

Chaetognaths present in surface plankton tows made in the vicinity of the fringing reef north of Pine Cay.

species	maturity stage	4/7/88 0800-0825	4/18/88 0808-0911
Flaccisagitta enflata	I	4	124
	II	-	4
	III	-	1
F. hexaptera	I	-	1
Krohnitta pacifica	I	-	5
	II	-	11
	III	-	5
Pterosagitta draco	I	2	26
	II	-	1
Sagitta bipunctata	II	-	1
	I	13	16
	II	5	8
Serratosagitta serratodentata	III	3	3

Ecology and distribution: *Pterosagitta draco* is an oceanic species, epipelagic to upper mesoplanktonic in tropical and subtropical areas (Owre 1960; Alvario 1965), and has been found associated with mixed water along continental shelf regions (Pierce 1962; Pierce and Wass 1962; Saint-Bon 1963; McLelland 1984).

***Sagitta bipunctata* Quoy and Gaimard, 1827**

Sagitta californica, Michael 1913

Sagitta atlantica, Gray 1922

Sagitta hispida (non Conant), Burfield and Harvey, 1926

Sagitta multidentata, Hsü 1943

Ecology and distribution: This oceanic species is epipelagic to upper mesoplanktonic in temperate to tropical waters (Owre 1960; Alvario 1965; Legaré and Zoppi 1961), where it is considered an indicator of high-salinity, oceanic water (Pierce 1953; Grant 1963).

***Serratosagitta serratodentata* (Krohn, 1853)**

Sagitta serrato-dentata, Krohn 1853

Sagitta serratodentata, Langerhans 1880

Spadella serratodentata, Grassi 1883

Sagitta serratodentata serratodentata, Pierrot-Bults 1974

Serratosagitta serratodentata, Tokioka 1965

Ecology and distribution: An epipelagic, oceanic form, the subspecies described by Pierrot-Bults is wide-

spread in tropical and sub-tropical Atlantic waters. It was collected near the surface at three stations in the Bahamas by Owre (1972). As is the case for the other planktonic species reported here, the presence of *S. serratodentata* in coastal waters indicates the influence of offshore currents.

Epibenthic species (Figure 2, Table 3)

Most specimens of *Paraspadella nana* and *P. schizoptera*, of the family Spadellidae (Tokioka 1965), were taken from shallow water (1-1.5 m) algal-sponge-coral washings at Fort George Cay across the channel from Pine Cay, and at Rockwash and Mud Shrimp Cays, two islets on the shallow Caicos Banks east of Pine Cay (Fig. 1). Additional specimens of *P. schizoptera* were collected with the yabby pump from sediment samples at the shallow fringing reef northwest of Pine Cay. One specimen of *Spadella cephaloptera* was taken from a bag of sand collected by Cherie Heard (4 Nov. 1988) from 110-120 ft (35 m) on a silt-sand bottom near the seaward edge of the fringing reef northwest of Pine Cay.

The specimens of *P. nana* greater than 1.80 mm were all mature or nearly so (Table 4). Meristic characters fell within ranges published by Owre (1963, 1972) for Caribbean specimens. The species (Fig. 2f-i) is easily identified by its small size, two wide lateral adhesive processes emerging anterior to the seminal vesicles, and large ova that bend the gut into an 'S' shape. Two mature specimens had the peculiar hernia midway between the seminal vesicles and tip of the tail noted by Owre (1963). Specimens of *P. schizoptera* (Fig. 2a-e), 1.41-4.00 mm, were identified mainly by the presence of four thin, elongate digitate adhesive processes. Also notable are the elongate anterior teeth that protrude prominently outward when the hooks are extended (Fig. 2d). Paired lateral fins, described by Conant (1895) and Michel (1984) from animals of up to 4.6 mm, were not observed on any Pine Cay specimens. The two 'pairs' of lateral fins described by some authors are not apparent during early growth as seen in Feigenbaum's (1976) developmental study of the species. The lateral fin should be considered as a single structure constricted into anterior and posterior lobes by the protruding genital receptacular apparatus ('funnels'), which becomes prominent as the animal approaches maturity (H.B. Michel, pers. comm. 1989). For this reason we chose to adopt Bowman and Bieri's (1989) revision of Spadellidae systematics which divided the family into two genera based on the presence or absence of adhesive organs (*Paraspadella* and *Spadella*, respectively), and discounted the presence of true paired lateral fins. By definition, the species *nana*, *pulchella*, *hummelinki*, *schizoptera*, and *anops*, all possessing adhesive organs, now belong to the genus *Par-*

Table 3

Chaetognaths present in benthic and epibenthic collections made near Pine Cay (Table 1).
Numbers and maturity stages.

Species	Mat Stage	COLLECTIONS																					
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Spadella cephaloptera	II	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraspadella nana	I	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-
	II	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	2	4	-	-	
	III	5	5	-	-	-	-	-	-	-	6	-	-	-	2	-	-	-	1	5	-	-	
	IV	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	-	-	
Paraspadella schizoptera	I	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	3	-	-	-	
	II	1	1	-	-	-	-	-	1	2	2	-	3	-	-	1	-	-	5	5	-	-	
	III	2	-	-	-	-	-	-	-	2	2	-	3	-	-	2	-	-	-	7	-	-	
	IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
Ferosagitta hispida	I	-	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
	II	-	-	-	84	21	32	-	-	-	-	5	-	-	-	-	2	-	-	-	4	8	32
	III	-	-	-	7	11	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3	8
	IV	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Flaccisagitta enflata	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	

aspadella. Bowman and Bieri's revision rectified an earlier proposal by Salvini-Plawen (1986), which based the systematics partly on the numbers of lateral fin pairs.

Paraspadella nana and *P. schizoptera* are both common in shallow waters of the Bahamas and southeastern Florida (Owre 1972; Michel 1984). *Paraspadella schizoptera* has also been reported from Japan (Yosii and Tokioka 1939), 70-100 m. off New South Wales, Australia (Mawson 1944), and Soldier Key, Florida (Owre 1963). The Japanese record has been designated as a new species, *P. caecafera*, by Salvini-Plawen (1986) based on its lack of anterior fins and presence of intestinal diverticula. Two other species of the genus not found in this study, *P. pulchella* (Owre, 1963), and *P. hummelincki* (Alvarinho, 1970), have been reported from the Bahamas and surrounding waters, although the latter is probably a synonym of the former (Owre 1973), and therefore, likely occur in the Turks and Caicos Islands. The three epibenthic species are listed with synonyms and ecological notes:

Spadella cephaloptera (Busch, 1851)

Sagitta cephaloptera, Busch 1851

Spadella cephaloptera, Ritter-Záhony 1911

Ecology and distribution: This species has a cosmopolitan distribution in temperate and tropical seas and is abundant in shallow waters of the Bahamian islands and in southern Florida (Owre 1972; Michel 1984). Owre (1972) reported it to be associated with a variety of substrata including sand bottoms and *Thalassia* sea grass in waters ranging in depth from 0.5 to 15 m. Surprisingly, only a single specimen was collected during this study, one from a sand bottom at 35 m.

Paraspadella nana (Owre, 1963)

Spadella nana, Owre 1963

Gephyrospadella nana, Salvini-Plawen 1986

Ecology and distribution: This species was described from specimens associated with mixed algae and turtle grass (*Thalassia testudinum*) at 5-8 feet off Soldier Key, Florida (Owre 1963). Owre (1972) indicated that it might be associated with plant growth on sandy bottoms in the Bahamas, where it was found at 19 of 36 stations in depths of 1 to 10 meters. In our study, it was consistently found associated with the coralline alga, *Neogoniolithon* sp., and with sponge-algal communities in shallow water.

Table 4

Meristic values of some chaetognaths from Pine Cay, Turks and Caicos Islands.

SPECIES	Total Length mm	% Tail	Hooks	Ant. Teeth	Post. Teeth	Mat. Stage	No. Specimens
<i>Ferosagitta hispida</i>							
	6.80	27.6	8	6	10	II	1
	7.60	26.7	7	5	10	III	1
	7.70	25.8	8	-	-	III	1
	8.50	27.2	8	7	14	IV	1
	8.60	27.9	7	7	12	IV	1
	8.70	25.4-26.9	7-8	5-7	11	III	2
	8.90	26.3	8	6	10	III	1
	9.30	26.3-27.9	7.8	6	12	IV	2
<i>Spadella cephaloptera</i>							
	2.40	48.6	10	4	-	II	1
<i>Paraspadella nana</i>							
	1.20	50.9	7	1	-	I	1
	1.36	48.4	8	2	-	II	1
	1.50	48.5-51.5	8	2	-	I-II	2
	1.60	47.3	8	2	-	II	1
	1.70	48.1-50.5	8	2-3	-	II	2
	1.74	51.9	8	3	-	I	1
	1.80	48.8-50.0	7-8	2-3	-	II-III	3
	1.85	48.8	8	2	-	II	1
	1.87	49.4	8	2	-	III	1
	1.89	50.0	8	3	-	III	1
	1.90	52.9	8	2	-	II	1
	1.91	48.3-49.4	8-9	2	-	III	2
	1.94	46.6-50.0	8	2	-	III	2
	1.96	47.2-49.0	7	2	-	III	2
	2.00	48.4-53.8	8	2-3	-	III-IV	7
	2.08	48.9-50.0	7-9	2-3	-	III	2
	2.10	46.9-52.1	8-9	2-3	-	III-IV	5
	2.13	46.4-49.5	8	2-4	-	III	2
	2.16	49.1	8	3	-	III	1
	2.20	48.0-51.0	8	3	-	III-IV	4
	2.26	48.7	7	2	-	III	1
	2.30	44.3	7	1	-	III	1
	2.32	47.4-49.1	7-8	2	-	IV	3
	2.42	47.1	8	2	-	IV	1
	3.20	50.0	10	4	-	III	1
	3.50	49.0	9	5	-	III	1
<i>Paraspadella schizoptera</i>							
	1.41	48.4	8	3	-	I	1
	1.50	49.3	7	2	-	I	1
	1.56	45.1	8	1	-	I	1
	1.60	47.9	8	3	-	I	1
	1.70	46.1	-	-	-	I	1
	1.80	50.0	8	2	-	II	1
	1.90	52.3	8	2	-	II	1
	2.00	48.9	8	2	-	II	1
	2.02	48.9	8	3	-	II	1
	2.10	48.5	9	2	-	II	1
	2.30	48.5-50.9	8-10	2-3	-	II	5
	2.40	42.2	8	3	-	II	1
	2.46	48.2	8	3	-	II	1

Table 4 (Continued)

SPECIES	Total Length mm	% Tail	Hooks	Ant. Teeth	Post. Teeth	Mat. Stage	No. Specimens
	2.49	48.7	9	3	-	III	1
	2.50	48.7	9	3	-	II	1
	2.60	49.2-50.4	8	2-3	-	II-III	2
	2.68	47.8	9	3	-	II	2
	2.77	45.2	8	3	-	III	1
	2.86	47.7	9	3	-	II	1
	2.88	49.6	9	1	-	II	1
	2.90	45.8-48.5	9-10	2-3	-	II-III	2
	2.92	45.2	9	3	-	III	1
	2.95	46.3	8	4	-	III	2
	3.10	45.0-43.4	9	3	-	III	2
	3.20	48.3	9	2	-	II	1
	3.30	46.7-49.0	9-10	3-4	-	II-III	2
	3.40	49.0	9	2	-	III	1
	3.44	50.0	8	3	-	III	1
	3.50	40.1-49.4	9-10	3	-	III-IV	2
	3.60	47.9-50.3	9-10	3	-	III	2
	3.70	47.6-47.8	9-10	3	-	III	2
	4.00	47.3	9	4	-	IV	1

Paraspadella schizoptera (Conant, 1895)*Spadella schizoptera*, Conant 1895*Paraspadella schizoptera*, Salvini-Plawen 1986*Paraspadella schizoptera*, Bowman and Bieri 1989

Ecology and distribution: Originally, *P. schizoptera* was described from three specimens collected with a plankton net "at rising tide" from Bimini in the Bahamas (Conant 1895). It has since been found associated with mixed algae off Soldier Key, Florida (Owre 1963), and sandy bottoms from 0.5 to 10 meters in the Bahamas and Biscayne Bay, Florida (Owre 1972). It was present in nine collections from Pine Cay in waters of 1 to 10 m and associated with coralline algae, sponges, and rubble bottoms.

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REFERENCES CITED

- Aida, T. 1897. Chaetognaths of Misaki Harbor. *Annot. Zool. Jpn.* 1:13-21.
- Almeida-Prado, M.S. de. 1960. A new species of *Sagitta* from the southern Brazilian coast. *Acad. Bras. de Cienc.* 32(2):275-280.
- . 1968. Distribution and occurrence of Chaetognatha off Cananeia and Santos Coast. *Bol. Inst. Oceanogr., Sao Paulo* 17(1):33-55.
- Alvarado, A. 1965. Chaetognaths. *Ann. Rev. Oceanogr. Mar. Biol.* 3:115-194.
- . 1969. Los quetognatos del Atlántico. Distribucion y notas esenciales de sistemática. *Trab. Inst. esp. Oceanogr.* 37. 290 pp.
- . 1970. A new species of *Spadella* (benthic Chaetognatha). *Stud. Fauna Curaçao and Other Caribb. Isl.* 125(34):73-89.
- Boltovskoy, D. 1981. Chaetognatha. In: Atlas del zooplankton del Atlántico Suboccidental. D. Boltovskoy, Ed., *Publ. Inst. Nac. Invest. y Des. Pesc. (INIDEP)*, Argentina. pp. 759-791.
- Bowman, T.E., and R. Bieri. 1989. *Paraspadella anops*, new species, from Sagittarius Cave Grand Bahama Island, the second troglobitic chaetognath. *Proc. Biol. Soc. Wash.* 102(3):586-589.
- Burfield, S.T., and J.W. Harvey. 1926. The Chaetognatha of the Sealark expedition. *Trans. Linn. Soc. Lond. Ser. 2 (Zool.)* 19(1):93-119.

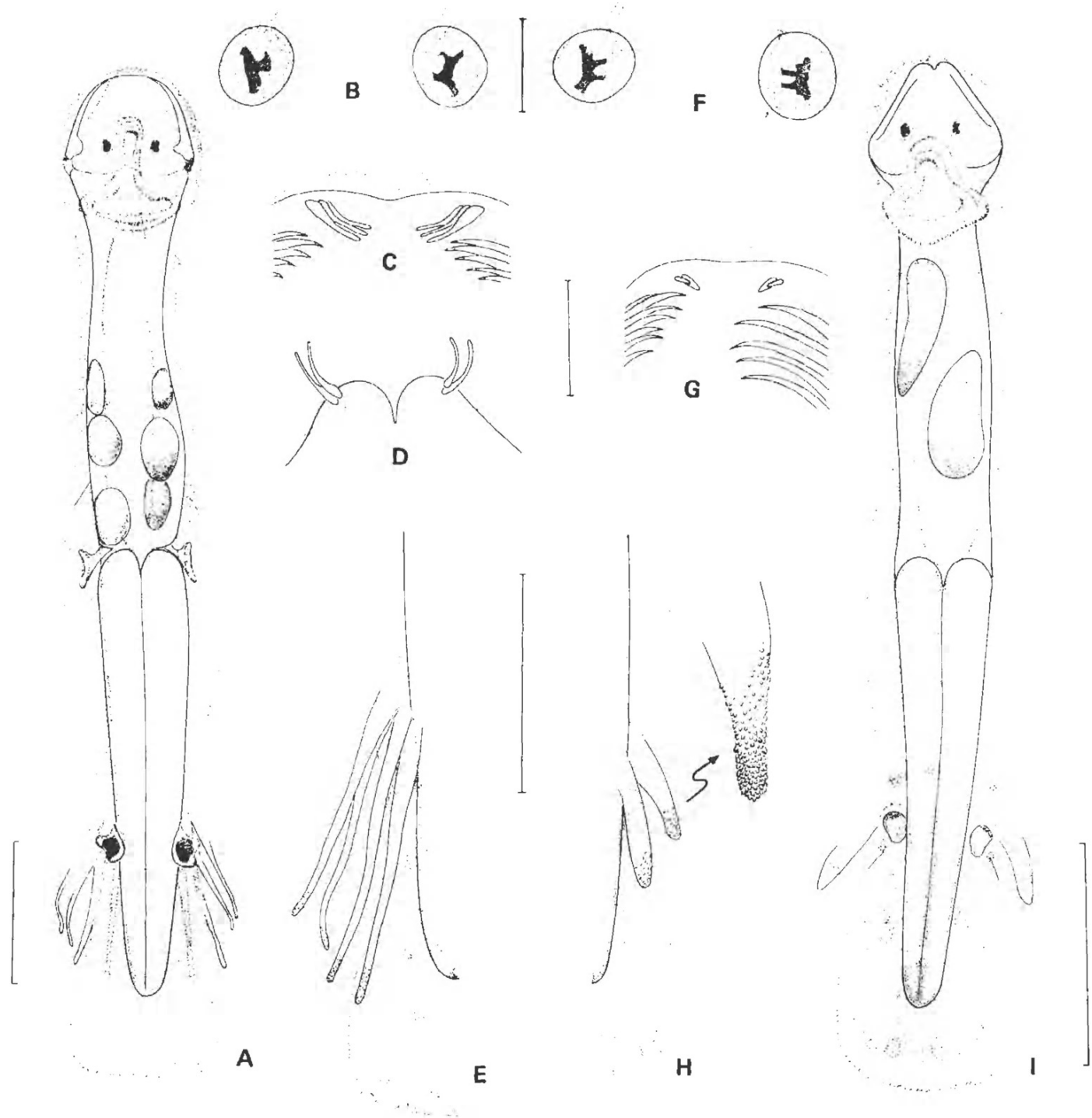


Figure 2. A-E, *Paraspadella schizoptera*. F-I, *Paraspadella nana*. A, I, whole animal, dorsal view; B, F, left and right eyes; C, G, anterior teeth with hooks retracted, ventral view; D, protruding anterior teeth when hooks are extended, ventral view; E, H, detail of adhesive processes, ventral view. Scales: A, E, H, I = 0.5 mm; B-D, F, G = 0.1 mm.

Busch, W. 1851. Beobachtungen über Anatomie und Entwicklung einiger wirbellosen Seethiere. Chaetognatha. Berlin, 4:93-100.

Colman, J.S. 1959. The "Rosaura" expedition 1937-38. Chaetognatha. Bull. Br. Mus. (Nat. Hist.) Zool. 5(8):219-253.

Conant, F.S. 1895. Description of two new chaetognaths (*Spadella schizoptera* and *Sagitta hispida*). Ann. Mag. Nat. Hist., Ser. 6, 16:288-292.

Costa, A. 1869. Di un nuovo genere di Chaetognati. Ann. Mus. Zool. Reale Univ. Napoli. 5:54.

- David, P.M. 1963. Some aspects of speciation in the Chaetognatha. In: Speciation in the Sea (symp.). J.P. Harding & N. Tebble, Eds., *Publs. Syst. Assoc.* 5:129-143.
- Doncaster, L. 1903. Chaetognatha, with a note on the variation and distribution of the group. *Fauna Geogr. Maldivo-Laccadive Archip.* 1:209-218.
- d'Orbigny, A. 1843. Voyage dans l'Amerique meridionale, Mollusques, Paris, 5(10):140-144.
- Feigenbaum, D.L. 1976. Development of the adhesive organ in *Spadella schizoptera* (Chaetognatha) with comments on growth and pigmentation. *Bull. Mar. Sci.* 26(4):600-603.
- Fumestini, M.L. 1966. Chaetognathes des eaux Africaines. *Atl. Rep. Sci. Résult. Dan. Exp. Coast Trop. West Afr.* 9:105-135.
- Germain, I. & L. Joubin. 1916. Chétognathes provenant des campagnes des yachts *Hirondelle* et *Princesse-Alice* (1885-1910). *Résult. Camp. Sci. Monaco* 49:1-118.
- Grant, G.C. 1963. Investigations of inner continental shelf waters off lower Chesapeake Bay. Part IV. Descriptions of the Chaetognatha and a key to their identification. *Chesapeake Sci.* 4(3):107-119.
- Grassi, B. 1881. Intorno in chetognati. *Reale Inst. Lombardo Sci. Let. Rend., Ser. 2*, 14(6):193-213.
- . 1883. I Chetognati. *Fauna Flora Golf. Neapel*, 5:1-126.
- Gray, B.B. 1922. Notes on species of 7 collected during a voyage from England to Australia. *Proc. R. Soc. Queensl.* 34:171-180.
- Hsu, F. 1943. Species of *Sagitta* from China. *Sinensia, Shanghai* 14(1-6):129-139.
- Johnston, T.H. 1909. An Australian chaetognath. *Rec. Aust. Mus.* 7:251-256.
- Kassatkina, A.P. 1971. New neritic species of chaetognaths from the Possjet Bay of the Sea of Japan. *Issled. Fauny Morei* 8:265-294.
- Krohn, A. 1853. Nachtragliche Bemerkungen über den Bau der Gattung *Sagitta* nebst der Beschreibung einer neuen Arten. *Arch. Naturgesch.* 19(1):1-286.
- Langerhans, P. 1880. Die Wurmfuna von Madeira. *Acitschr. Wiss. Zol.* 34:132-136.
- Legaré, J.E.H., & E. Zoppi 1961. Notas sobre la abundancia y distribution de Chaetognatha in las aguas del oriente de Venezuela. *Bol. Inst. Oceanogr.* 1(1):1-25.
- Mawson, P.M. 1944. Some species of Chaetognath genus *Spadella* from New South Wales. *Trans R. Soc. S. Aust.* 68(2):327-333.
- McLelland, J.A. 1984. Observations on chaetognath distributions in the northeastern Gulf of Mexico during the summer of 1974. *Northeast Gulf Sci.* 7(1):49-59.
- . 1989. An illustrated key to the Chaetognatha of the northern Gulf of Mexico with notes on their distribution. *Gulf Res. Rept.* 8(2):145-172.
- Michael, E.L. 1911. Classification and vertical distribution of the Chaetognatha of the San Diego Region. *Univ. Calif. Publ. Zool.* 8(3):21-186.
- . 1913. *S. californica*, sp. n. from the San Diego region. *Univ. Calif. Publ. Zool.* 11(5):p.125.
- Michel, H.B. 1984. Chaetognatha of the Caribbean Sea and adjacent areas. *NOAA Tech. Rep. NMFS 15*, U.S. Dept of Commerce. 33 pp.
- . M. Foyo, & D.A. Haagensen. 1976. Caribbean zooplankton. Part 1 - Siphonophora, Heteropoda, Copepoda, Euphausiacea, Chaetognatha, and Salpidae. publ. by Office of Nav. Res., Dept. of Navy, U.S. Govt. printing office, Washington, D.C. 549 pp.
- Moltschanoff, L.A. 1907. Die Chaetognathen des Zoologischen Museums der Kaiser Academie der Wissenschaften in St. Petersburg. *Ann. Mus. Zool. Acad. Sci. St. Petersburg.* 12:203-212.
- Owre, H.B. 1960. Plankton of the Florida Current. Part VI. The Chaetognatha. *Bull. Mar. Sci.* 10(3):255-322.
- . 1963. The genus *Spadella* (Chaetognatha) in the western North Atlantic Ocean, with descriptions of two new species. *Bull. Mar. Sci. Gulf Caribb.* 13(3):378-390.
- . 1972. The genus *Spadella* and other Chaetognatha. *Sarsia* 49:49-58.
- . 1973. A new chaetognath genus and species, with remarks on the taxonomy and distribution of others. *Bull. Mar. Sci.* 23(4):948-963.
- Oye, P. 1918. Untersuchungen über die Chaetognathen des Javameeres. *Contr. Faune Indes Néerl.* 4:1-61.
- Pierce, E.L. 1953. The Chaetognatha over the continental shelf of North Carolina with attention to their relation to the hydrography of the area. *J. Mar. Res.* 12(1):75-92.
- . 1962. Chaetognatha from the Texas coast. *Publ. Inst. Mar. Sci., Univ. Tex.* 8:147-152.
- . & M.L. Wass. 1962. Chaetognatha from the Florida Current and coastal water of the southeastern Atlantic states. *Bull. Mar. Sci.* 12(3):403-436.
- Pierrot-Bults, A.C. 1974. Taxonomy and zoogeography of certain members of the "*Sagitta serratodentata*-group" (Chaetognatha). *Bijdr. Dierkd.* 44(2):215-234.
- Quoy, J., & P. Gaimard. 1827. Observations zoologiques faites a bord de l'*Astrolabe* in Mai 1826 dans le detroit de Gibraltar. *Ann. Sci. Nat. (Zool.)* 10:230-232.
- Ritter-Záhony, R. Von. 1908. Chaetognathen. In: Zoologische ergebnisse der expedition S.M.S. *Pola* in das Östliche Mittelmeer 1890-1894. *Denk. Akad. wiss. Wien., Bd. 84., S.* 789.
- . 1910. Westindische Chätognathen. *Zool. Jahrb. Abt. Allg. Zool. Physiol. Tierre.* Suppl. 11:133-143.
- . 1911. Revision der Chätognathen. *Dtsch. Sudp. Exped.* 13:1-71.
- Saint-Bon, M.C. de. 1963. Les Chaetognathes de la Cote d'Ivoire (especes de surface). *Rev. Trav. Inst. (Scient. Tech.) Pêch. Marit.* 27(3):301-346.
- Salvini-Plawen, L. v. 1986. Systematic notes on *Spadella* and on the Chaetognatha in general. *Z. Zool. Syst. Evolutionforsch.* 24:122-128.
- Suárez-Caastro, J.A. 1955. Quetognatos de los Mares Cubanos. *Mem. Soc. Cub. Hist. Nat.* 22(2):125-180.
- Tokioka, T. 1939. Chaetognatha collected chiefly from the bays of Sagami and Suruga, with some notes on the shape and structure of the seminal vesicles. *Rec. Oceanogr. Works Jpn.* 10(2):123-150.
- . 1965. The taxonomic outline of Chaetognatha. *Publ. Seto Mar. Biol. Lab.* 12(5):335-357.
- Vannucci, M., & K. Hosoe. 1952. Resultados científicos do cruzeiro de "*Baepandi*" e do "*Vega*" a Ilha da Trindade. Chaetognatha. *Bol. Inst. Oceanogr. Sao Paulo* 3(1-9):5-30.
- Yosii, N., & T. Tokioka. 1939. Notes on Japanese *Spadella* (Chaetognatha). *Annot. Jpn.* 18(4):267-273.



McClelland, Jerry A and Heard, Richard W. 1991. "Notes on Some Chaetognaths from Pine Cay, Turks and Caicos Islands (British West Indies)." *Gulf research reports* 8(3), 227-235. <https://doi.org/10.18785/grr.0803.02>.

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