

## A dwarf *Spadella* (Chaetognatha) from Bora Bay (Miyako Island, Japan)

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**Abstract:** A new benthic chaetognath, *Spadella boucheri* sp. nov., is described from Bora Bay, Miyako Island, near Okinawa (Japan). It is presently the smallest known species of the phylum. Its small size and the narrowness of its lateral fins suggest that it could live occasionally between the sand grains of the superficial substrate, a behaviour that had been previously hypothesized for a *Spadella* from the European waters. The problem of endemism of chaetognaths living in semi-closed bays of islands scattered in the open ocean is discussed.

**Résumé :** Une *Spadelle naine* (*Chaetognatha*) de la baie de Bora (Île de Miyako, Japon). Un nouveau Chaetognathe benthique, *Spadella boucheri* sp. nov., est décrit de la baie de Bora, près d'Okinawa (Japon). C'est actuellement la plus petite espèce du phylum. Sa petite taille et l'étroitesse de ses nageoires latérales suggèrent qu'elle pourrait vivre occasionnellement entre les grains de sable à la surface du substrat, un comportement qui avait déjà été supposé chez une *Spadella* des eaux européennes. Le problème de l'endémisme des Chaetognathes vivant dans des baies semi-fermées d'îles disséminées en plein océan est discuté.

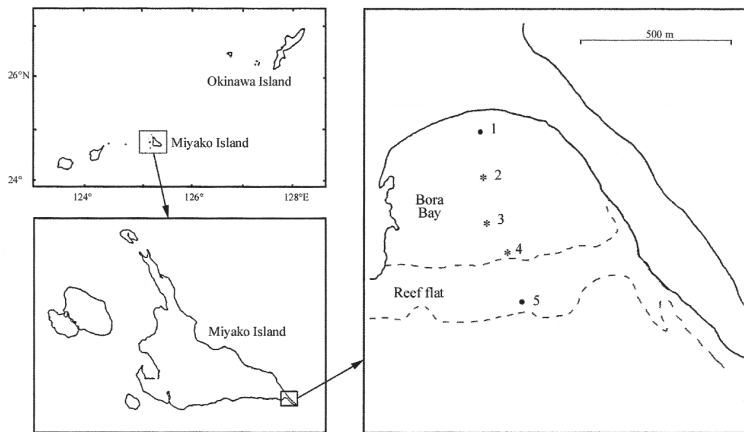
**Keywords :** Chaetognatha, *Spadella*, Japan, taxonomy, endemism.

### Introduction

When sorting the meiofauna from samples of coral sand of Bora Bay, Miyako Island, south of Okinawa (Japan), our colleague Dr. G. Boucher (Muséum National d'Histoire Naturelle, Paris) found many specimens of a very small undescribed *Spadella*. All stages of the life cycle of this new species were present.

### Material

Thirty nine specimens were found and examined, in three out of five stations located on a transect from the coast to the reef across the lagoon of Bora Bay (coordinates: 24° 38' N-125° 35' E) (Fig. 1), on October 20, 1995. Three replicate 10 cm<sup>2</sup> hand-cores were taken by SCUBA diving at each station and fixed immediately in 5% formalin. Sample collection was limited to the first five cm of the substrate. The meiofauna was extracted by Ludox TM centrifugation in the laboratory and sorted by hand.



**Figure 1.** Sampling area of *Spadella boucheri* sp. nov. in Bora Bay (positive stations: asterisks, negative stations: circles), on the south east coast of Miyako Island, Japan (modified from Casareto et al., 1995).

**Figure 1.** Aire de récolte de *Spadella boucheri* sp. nov. à Bora Bay (stations positives : astérisques, stations négatives : cercles), sur la côte sud-est de l'île Miyako, Japon (modifié d'après Casareto et al., 1995).

## Result

### *Spadella boucheri*, sp. nov.

**Types:** The holotype and two paratypes are deposited at the the National Science Museum, Tokyo (NSMT - Ch. 28 and 29), and other paratypes at the Muséum National d'Histoire Naturelle, Paris, (MNHN Reg. number UE 935, 936 and 937).

**Etymology:** This new species is named after Dr. G. Boucher for his kindness in sending us the material for identification.

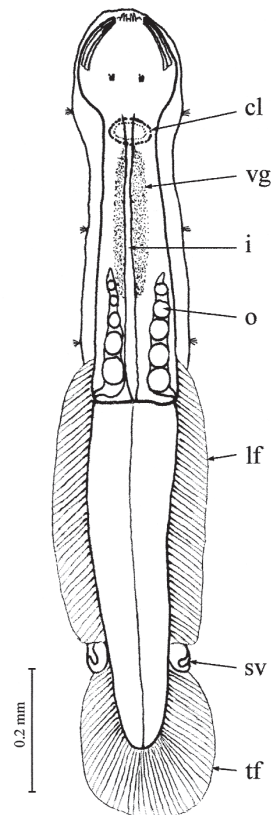
### Description

Body elongated and rigid. Total length when mature, 1.1 to 1.3 mm, tail fin not included. Tail segment represents about 50% of total body length (Fig. 2).

Head more or less rounded (Fig. 3A). A maximum of seven paired hooks, thin and slightly curved, the base of the longest enlarged (Fig. 3B). Anterior teeth, three on each side, very stout, slightly flattened in lateral view and ornamented with ridges (Figs 3C-E). No posterior teeth. Vestibular organs crescent-shaped, composed of a rank of nipples in these preserved specimens, each of them ending in a small knob (Figs 3C-E). Eyes situated posteriorly on head, pigment cell H-shaped (Figs 3A, F). Corona ciliata oval and small, its largest axis narrower than the width of the neck (Fig. 3A). Collarette tissue not very abundant, stretching from the tip of the head to the end of the tail, largest in the neck region and thickest dorsally on the head. The collarette is thin ventrally and bears many large adhesive papillae from tail to mid-trunk (not shown). Gut straight; intestinal diverticula not observed, very small if

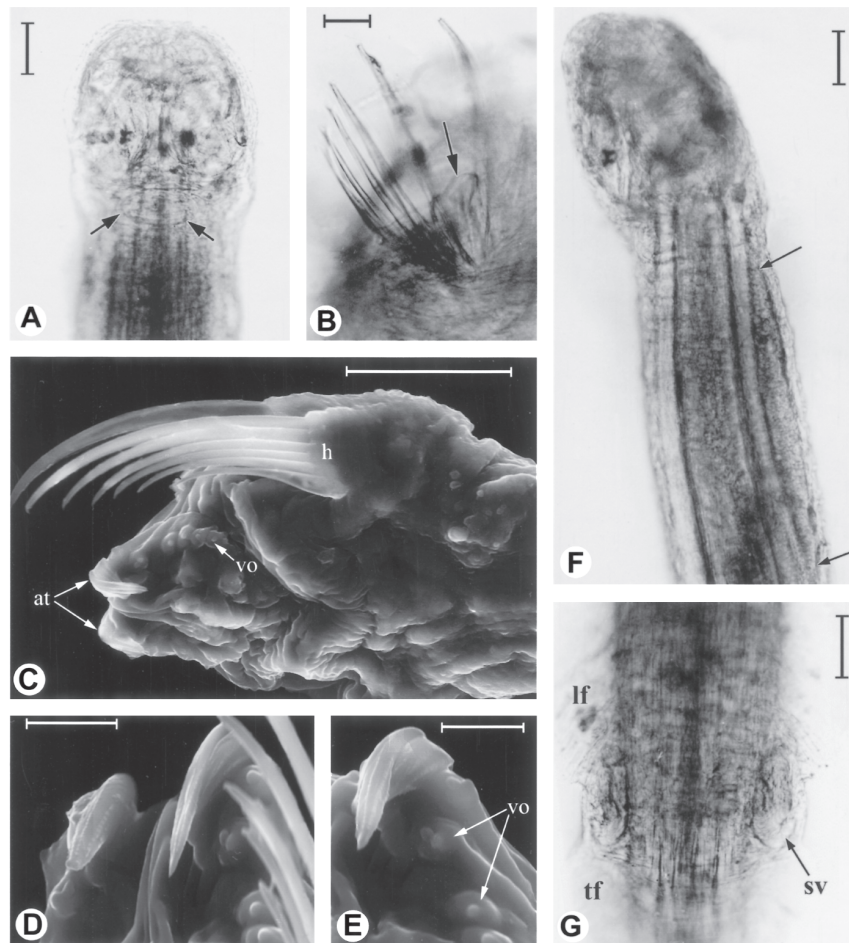
any. Transverse musculature in trunk not visible, owing to the small size and opacity of the body. Ventral ganglion very large, representing about 40% of the length of the anterior body part (head and trunk), and beginning at the level of the neck (Figs 2, 3F).

Lateral fins beginning on posterior part of trunk and in contact posteriorly with the seminal vesicles; they are straight and have nearly the same width all along their length (Fig. 2). Tail fin rounded posteriorly. All fins totally provided with rays. A maximum of five large ova (diameter 0.10 mm) in each mature ovary, and seminal receptacle filled with sperm in large specimens. Seminal vesicles hook-shaped when small, oval and larger when mature, in contact with both lateral and tail fins (Figs 2, 3G). The smallest juvenile specimens are 0.7 mm long; at this stage, the hooks are not yet visible and the anterior part of the head is straight.



**Figure 2.** Habitus of *Spadella boucheri* sp. nov. (dorsal view). (cl) ciliary loop, (i) intestine, (lf) lateral fins, (o) ovaries, (sv) seminal vesicles, (tf) tail fin, (vg) ventral ganglion.

**Figure 2.** Habitus de *Spadella boucheri* sp. nov. (vue dorsale). (cl) couronne ciliaire, (i) intestin, (lf) nageoires latérales, (o) ovaires, (sv) vésicules séminales, (tf) nageoire caudale, (vg) ganglion ventral.



**Figure 3.** *Spadella boucheri* sp. nov. **A, B, F, G** light micrographs, **A** anterior part of the body in dorsal view; **B** left hooks in lateral view; **F** anterior part of the body in right lateral view; **G** seminal vesicles in dorsal view. (Arrows) indicate in **A** the limits of the ciliary loop, in **F** the limits of the ventral ganglion, in **B** the enlarged base of one hook. Note, in **A** and **F**, the H-shaped pigment cell of eyes. **C-E**: SEM micrographs, **C** head in ventro-lateral view, **D, E** details of teeth and vestibular organs. (*at*) anterior teeth, (*h*) hooks, (*lf*) lateral fins, (*sv*) seminal vesicles, (*tf*) tail fin, (*vo*) vestibular organs. Scale bars: **A, C, F, G** = 50  $\mu$ m, **B** = 20  $\mu$ m and **D, E** = 10  $\mu$ m.

**Figure 3.** *Spadella boucheri* sp. nov. **A, B, F, G** : photomicrographies, **A** partie antérieure du corps en vue dorsale, **B** crochets gauches en vue latérale, **F** partie antérieure du corps en vue latérale droite, **G** vésicules séminales en vue dorsale. Les (flèches) indiquent en **A** les limites de la couronne ciliaire, en **F** celles du ganglion ventral, en **B** la base élargie d'un crochet. Noter, en **A** et **F**, la forme en H de la cellule pigmentée des yeux. **C-E** : micrographies au MEB, **C** la tête en vue ventro-latérale, **D, E** détail des dents et organes vestibulaires. (*at*) dents antérieures, (*h*) crochets, (*lf*) nageoires latérales, (*sv*) vésicules séminales, (*tf*) nageoire caudale, (*vo*) organes vestibulaires. Echelle : **A, C, F, G** = 50  $\mu$ m, **B** = 20  $\mu$ m et **D, E** = 10  $\mu$ m.

## Discussion

### Comparisons with related species

*Spadella boucheri* sp. nov. is now the eleventh described species of the genus. The main differential characteristics of the ten species known previously were reviewed a few years ago (Casanova, 1991, 1993). All these species are larger than *S. boucheri*. Four of them have always posterior teeth: *Spadella ledoyeri* Casanova, 1986, *S. birostrata* Casanova, 1987, *S. equidentata* Casanova, 1987 and *S. antarctica*

Casanova, 1991. The other six may or may not possess posterior teeth: *S. cephaloptera* (Busch, 1851), *S. moretonensis* Johnston & Taylor, 1919, *S. gaetanoi* Alvariño, 1978, *S. angulata* Tokioka, 1951, *S. bradshawi* Bieri, 1974 and *S. japonica* Casanova, 1993.

Owing to the absence of posterior teeth, *S. boucheri* belongs to the last group of species. Among them, it must be compared to the three last species which also have hook-shaped seminal vesicles, when not fully mature. The shape of those of *S. moretonensis* described from Australian waters (Johnston & Taylor, 1919) is unknown since the sole

specimen observed was not mature; nevertheless, the large body size (3.68 mm) and the corona ciliata, broader than the width of the neck, indicate that this species clearly differs from *S. boucheri*. These two characters, size of body and of corona ciliata, definitely indicate that *S. boucheri* is a new species. Indeed, the maximal sizes of *S. angulata*, *S. bradshawi* and *S. japonica* are respectively 5.8, 6.5 and 3.75 mm; as for the corona ciliata, it is always broader than the width of the neck in these three species. In addition, other clearly visible characters separate them from *S. boucheri*: the lateral fins are rounded in *S. angulata*, they do not touch the small seminal vesicles in *S. bradshawi*, and the orifice of the female genital opening is at the bottom of a cupel in *S. japonica*.

#### Habitat

The specimens were collected at three stations in the central part of the lagoon and near the internal part of the reef flat at depths of 3.5 and 4.0 m (Fig. 1, Tabl. 1). The species was absent at st. 1, near the coast, and at st. 5, about 50 m off the external edge of the reef (depths = 2.5 and 3.1 m, respectively). At all these stations, the bottom was sandy with either fine to medium-sized sand or coralline sand. The granulometry of the sand does not seem to have an influence on the distribution of *S. boucheri*, but the small length of this species and the shape of its lateral fins may be related to this habitat.

**Table 1.** Number of specimens of *Spadella boucheri* sp. nov. sorted in the different sand samples at 3 stations in Bora Bay.

**Tableau 1.** Nombre de spécimens de *Spadella boucheri* sp. nov. récoltés dans les différents échantillons de sable de trois stations de la baie de Bora

Station	Depth (in m)	Sample	Number of specimens
2	3.5	A	2
		B	10
3	4.0	A	3
		B	6
4	3.5	A	11
		B	7

*Spadella boucheri* is the smallest known chaetognath. Its maximum size is 1.3 mm, while it is 2.4 mm for *Spadella nana* Owre, 1963, and 2.7 mm for the smallest planktonic species, *Sagitta bedfordii* Doncaster, 1903. Its maximal width is about 0.25 mm, which corresponds to the size of the largest sand grains. Moreover, the body is slender and the lateral fins are narrow their entire length. Wide fins, as those of most species of *Spadella* and *Paraspadella* living in

neritic waters, would be favourable in the lagoon and on the reef flat, where sea water inflow and outflow are well marked (Kraines et al., 1998). On the other hand, *Spadella ledoyeri* exhibits reduced lateral fins, a feature considered to be an adaptation to life in the calm waters of deep marine caves (Casanova, 1986); such an adaptation is also seen in *Paraspadella anops*, the other cave dweller chaetognath (Bowman & Bieri, 1989). Thus, we consider that the dwarfism and the narrowness of the lateral fins of *Spadella boucheri* allow this species to live between sand grains and are an adaptation for a possible meiofaunal existence.

Such a trend has already been hypothesized for *Spadella cephaloptera*. According to John (1933), this species is buried in the mud off Plymouth. This behaviour was also noticed by Nouvel (1935) off Roscoff, and would help to resist low temperatures in winter. Ghirardelli (1963) observed many generations of this species all the year round on the Mediterranean coasts, issued from specimens sheltered on the bottom. Furnestin & Brunet (1965, 1968) also considered this occasional way of life as probable.

Our observations on the morphology of *S. boucheri* indicate a possible interstitial way of life. The ventral patches of adhesive gland cells in *Spadella boucheri*, are comparatively larger than those of other benthic-neritic species of *Spadella*, also exposed to water movements. Indeed these gland cells seem to be correlated with environmental conditions, since they are absent in species living in calm waters such as the caves and deep water. Adhesive organs are often found in interstitial animals and they are one of the typical features of interstitial turbellarians, gastrotrichs and polychaetes living in sediments exposed to wave movements. Thus in *S. boucheri* these well developed adhesive organs can be seen as an adaptation to an interstitial environment, allowing the animals to adhere to the sand grains.

*Spadella boucheri* is the fourth *Spadella* species described from Japanese waters where *S. cephaloptera*, *S. angulata* and *S. japonica* also live. In the area of Okinawa Island, at Yoron Island, only *S. angulata* has been found. The discovery of *S. boucheri* at Miyako Island, south of Okinawa, is an argument indicating that each island, isolated in the open ocean, might house a particular neritic species since this phenomenon seems also true for planktonic species (Tokioka, 1979). A new species of *Sagitta*, *S. madhupratapi* Casanova & Nair, 1999, has been described from the Agatti lagoon in the Laccadive Archipelago in the Indian Ocean and is also thought to be endemic. Further research is needed to test this hypothesis also for the benthic chaetognaths and to know if *Spadella boucheri* is truly endemic too. If the answer is yes, the benthic *Spadella* of the Japanese waters, that are easy to breed, would be a good model for studies on the evolutionary processes in chaetognaths.

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