

# *Falcidens sagittiferus* Salvini-Plawen, 1968: additional data on morphology and distribution (Mollusca, Aplacophora, Caudofoveata)

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*Falcidens sagittiferus* Salvini-Plawen, 1968 is a species of caudofoveate (Chaetodermomorpha) not uncommon in southern Scandinavia. Previous descriptions have however been based mainly on fixed material, and illustrations of sclerites and radula have been incomplete. We here present data from an investigation based on over 70 specimens from Norway (including the type material). Radula, sclerites and living specimens are illustrated.

Keywords: Scandinavia, Chaetodermomorpha, basal mollusc, living specimens

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## INTRODUCTION

Up to the present, about 130 species of Caudofoveata have been described, but for most of them, information about characters of living specimens, fine radula structure and birefringence pictures of sclerites are still not available. This paper is the first in a series planned to describe additional morphological, ecological and distributional data for known caudofoveate species.

## MATERIAL AND METHODS

More than 70 specimens were examined from the following collections: BIOICE (Ivanov & Scheltema 2001); Zoological Museum of the Moscow State University (ZMMU); R/V *Hans Brattström*, Korsfjord, 216-424 m, 60°12' N, 5°13' E, 12.11.2004; Bergen Museum, University of Bergen (ZMBN): entrance of Fanafjord, 190-180 m, 60°13'08" N, 5°14'30" E, 10.04.1969, det. Salvini-Plawen (No. 53042), Raunefjord, 200-180 m, 60°10'20" N, 5°10'55" E, (No. 53039), and holotype (No. 48371). (ZMMU)

Akvaplan-Niva: 61°26'-61°32'N, 2°07'-2°15'E, 306-355 m, 30.05.2002-07.06.2002 (12 specimens); 60°42'-61°05'N, 3°26'-3°40'E, 300-357 m, 01.06.2004-03.06.2004 (17 specimens); 71°29'N, 21°08'E, 275 m, 12.06.2003 (1 specimen).

Methods for studying caudofoveates and the taxonomic characters used here are given in full for Prochaetodermatidae in Scheltema and Ivanov (2004) and Ivanov & Scheltema (2008), with some techniques modified here. The characters are based on external appearance, including measurements of the anterior, neck, anterior - and posterior trunk, posterium, and the ratio of neck, anterior trunk and posterium to trunk length (Fig. 4C); on the morphology of sclerites including the dimensions of base and blade, longitudinal axis, and isochromes (lines of equal color when viewed under crossed polarized light (Fig. 4G), indicated by dotted lines (Fig. 2D); and on the morphology of isolated radulae (Fig. 2C). The greatest dimensions for available specimens are given for all measurements; greatest length x width x thickness is given for sclerites. Size measurements of body regions are given as length x diameter.

Two methods are used to remove sclerites. For holotypes or specimens of rare species, the entire specimen is placed in distilled water in a dish and, after 5 minutes, removed to a small drop of water on a flat slide. (Previously we used glycerine instead of water, but over time the sclerites dissolved after returning the specimens to alcohol.) Sclerites are then removed with a needle, holding the specimen with fine forceps, and air-dried. Permanent slides are made with a coverslip and Histomount®. If there is sufficient material of a species, an entire individual is placed in household bleach (hypochlorite) for 3-5 minutes; the specimens are thoroughly washed and are sclerites separated by body regions and placed onto a slide, air-dried, and mounted. For scanning electron microscopy (SEM) stubs, the same techniques are used as for slides. Stubs are either coated with a thin layer of reconstituted dried egg albumin or double coated carbon conductive tabs were used. Radulae are dissected and cleared of tissue in bleach and washed thoroughly before mounting. As air-drying of the material may cause distortion, our preferred method is to place a radula in a small drop of glycerine on a slide, covered with a small, round coverslip raised by small bits of broken coverslips. The preparation is then covered by a larger coverslip and Histomount®, sealing in the glycerine.

Living and fixed entire animals were here photographed with Nikon CoolPix 995 and a scope adapter mounted on a Wild M5 microscope. Drawings were made using a Wild M5 microscope equipped with a camera lucida. Birefringence pictures were taken using a Zeiss Axioscope microscope as described in Scheltema & Ivanov (2004). Scanning electron micrographs were taken using a JEOL 6400 at the University of Bergen, Norway.

## Taxonomy

CHAETODERMIDAE Théel, 1875

= Chaetodermatidae Ihering, 1876

***Falcidens Salvini-Plawen, 1968***

*Falcidens Salvini-Plawen, 1968: 114-115.*

Type species: *Falcidens crossotus* Salvini-Plawen, 1968 (original designation).

***Falcidens sagittiferus* Salvini-Plawen, 1968**

*Falcidens sagittiferus* Salvini-Plawen, 1968: 117, figs. 8, 9

Type locality: Raunefjorden in front of Lundanesset, SW of Bergen, 235 m.

Holotype: Zoologisk Museum, Bergen No. 48371 (entire speci-

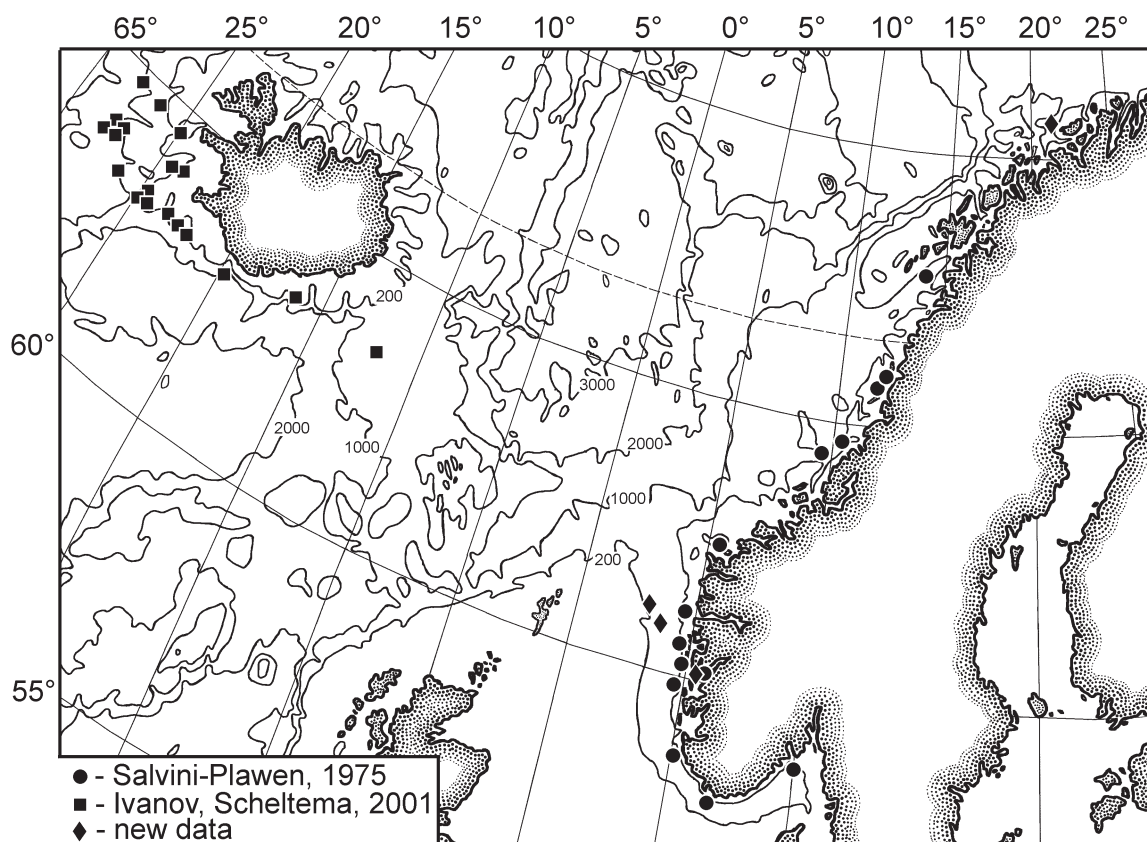


Figure 1. Distribution of *Falcidens sagittiferus* Salvini-Plawen, 1968.

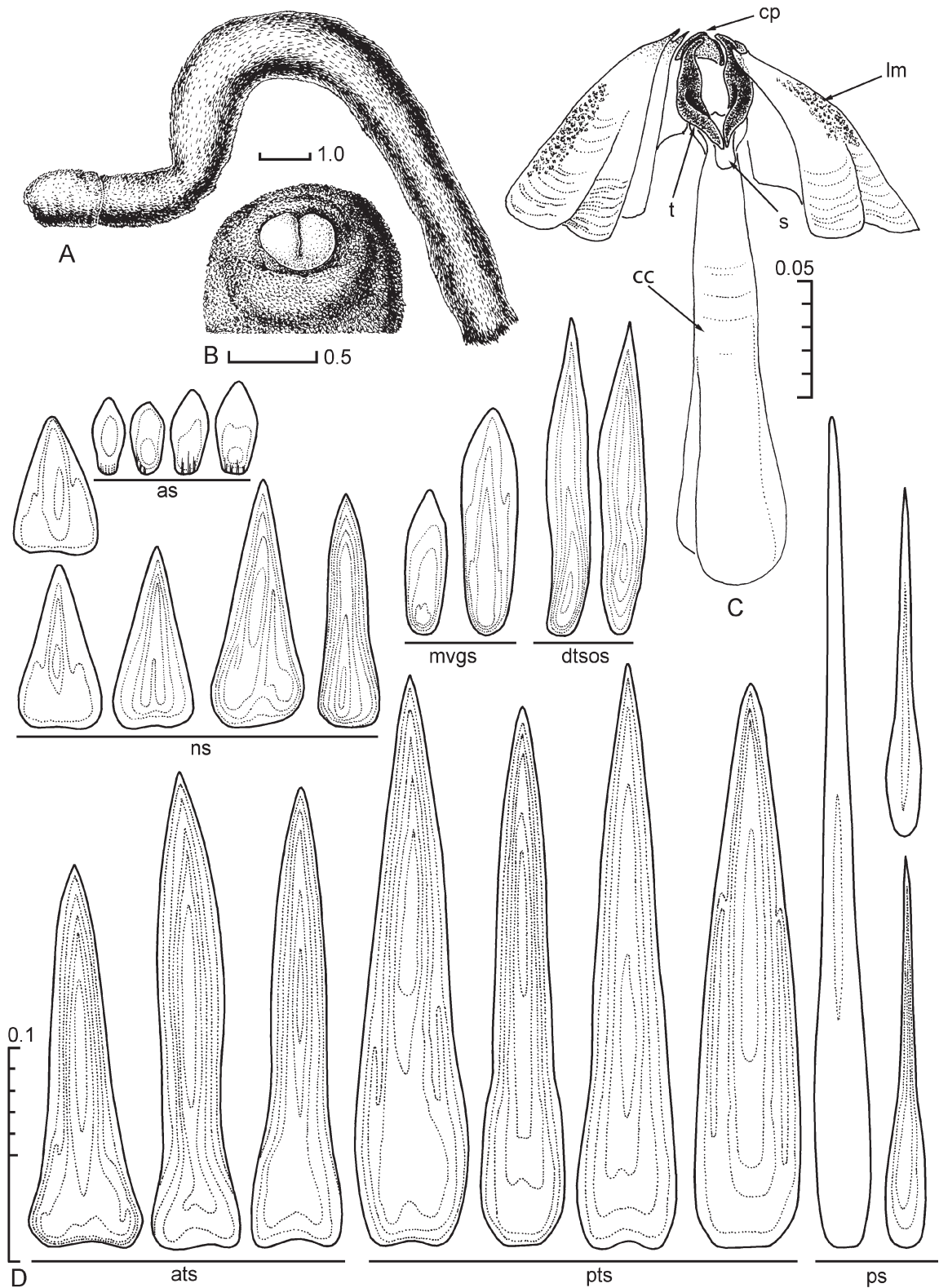


Figure 2. *Falcidens sagittiferus* Salvini-Plawen, 1968. A – entire specimen (ZMB No. 53042); B – oral shield; C – radula, *cc* – cuticular cone, *cp* – central plate, *lm* – lateral membrane, *s* – symphysis, *t* – tooth; D – sclerites from: *as* – anterior, *ats* – anterior trunk, *dtsos* – dorsoterminal sense organ, *mvgs* – midventral groove, *ns* – neck, *ps* – posterior, *pts* – posterior trunk (scale bars in mm).

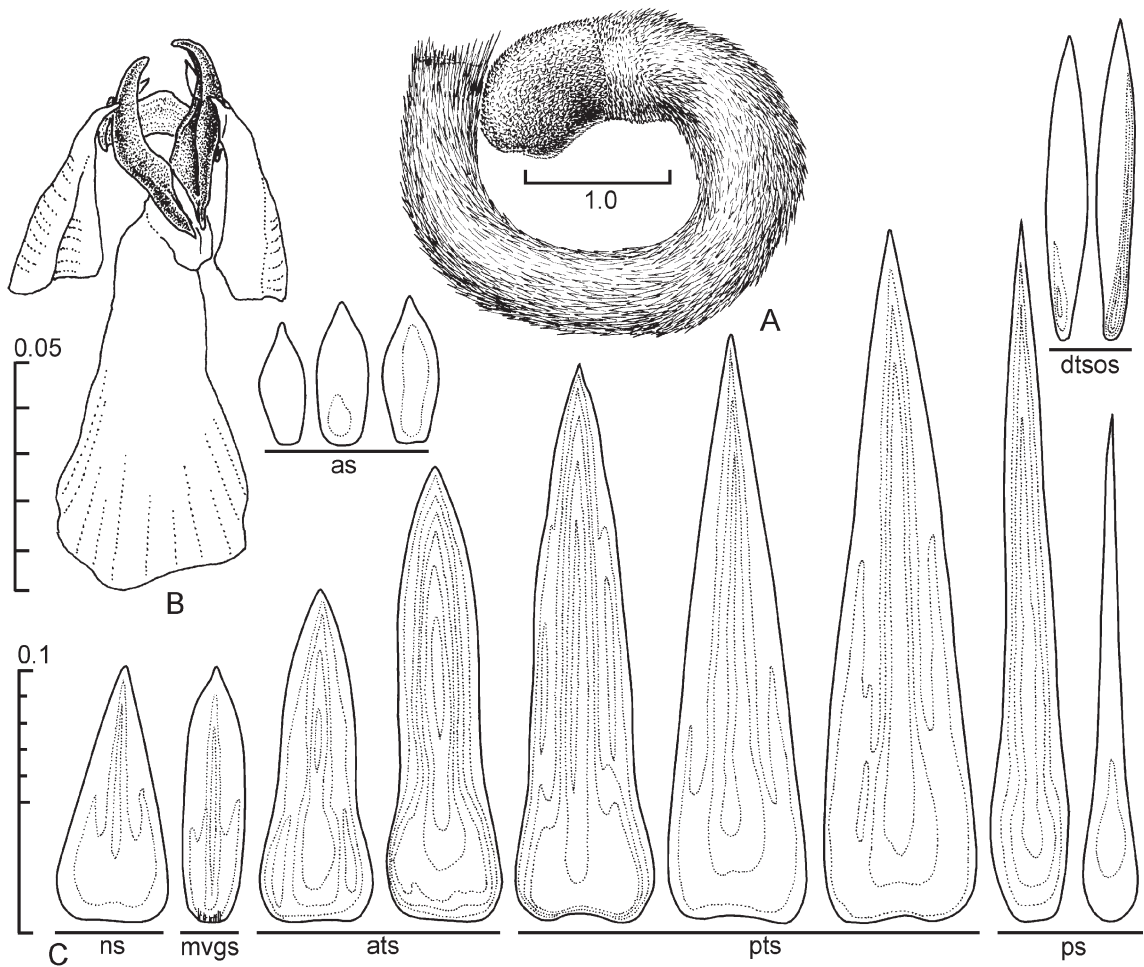


Figure 3. *Falcidens sagittiferus* Salvini-Plawen, 1968. A – entire juvenile specimen (R/V Hans Brattström); B – radula, oblique view; C – sclerites from: *as* – anterior, *ats* – anterior trunk, *dtsos* – dorsoterminal sense organ, *mvgs* – midventral groove, *ns* – neck, *ps* – posterior, *pts* – posterior trunk (scale bars in mm).

men in alcohol, sclerites started to dissolve, no slides with sclerites and radula). Length 11.0 mm, anterior 0.5 x 0.9 mm, neck 1.0 x 1.0 mm, anterior trunk 1.3 x 1.1 mm, posterior trunk 7.5 x 1.1 mm, posterium 0.7 x 0.6 mm; neck/trunk index 0.11, anterior/posterior trunk index 0.17, posterium/trunk index 0.08 (Fig. 4A).

**Distribution:** A temperate, Iceland to East Atlantic, near-continental species, living on the shelf and upper slope (Fig. 1), occurring at depths of 25 to 1695 m with summer bottom temperatures from 3.7 to 6.1°C, usually on sand, sandy silt and silt substrates. The lower limit of distribution of the species is deeper near Iceland (1695 m) than off Norway (680 m) (Salvini-Plawen 1968; 1970; 1975; Salvini-Plawen & Warén 1972; Ivanov & Scheltema 2001.)

**Diagnosis:** A small chaetodermatidae up to 20 mm in length, but usually from 10-15 mm, neck/trunk index 0.11-0.16, anterior trunk much shorter than posterior trunk index 0.16-0.20, posterium/trunk index 0.08-0.09; opaque, glistening; sclerites

long, adpressed on trunk, junction of neck and trunk clearly demarcated by circular groove; anterior trunk with midventral groove. Oral shield small, horseshoe-shaped. Trunk sclerites long, thin, straight, arrow-shaped, basally intended, length/width index 5-6, waist usually distinct, thickened symmetrically, distal end sharp, lateral edges of blades straight to slightly convex, sclerite surface with broad central keel and one or two pairs of longitudinal grooves, most distinct in thick middle part of sclerite. Midventral groove sclerites elongate, with rounded proximal end, without waist, blade shorter than base, central keel distinct, thickest medially on base, length/width index 3-4. Sclerotized sickle-shaped teeth of radula large, to 45-50 µm in length, attached by symphysis to the cuticular cone apically; central plate simple, ribbon-shaped, with angular thickened upper edge; lateral membranes short.

**Living specimen** (Fig. 4B): elongate, almost uniform in diameter along the body, silver-shiny; protruded anterior whitish-pink; neck and anterior trunk opaque; posterior trunk

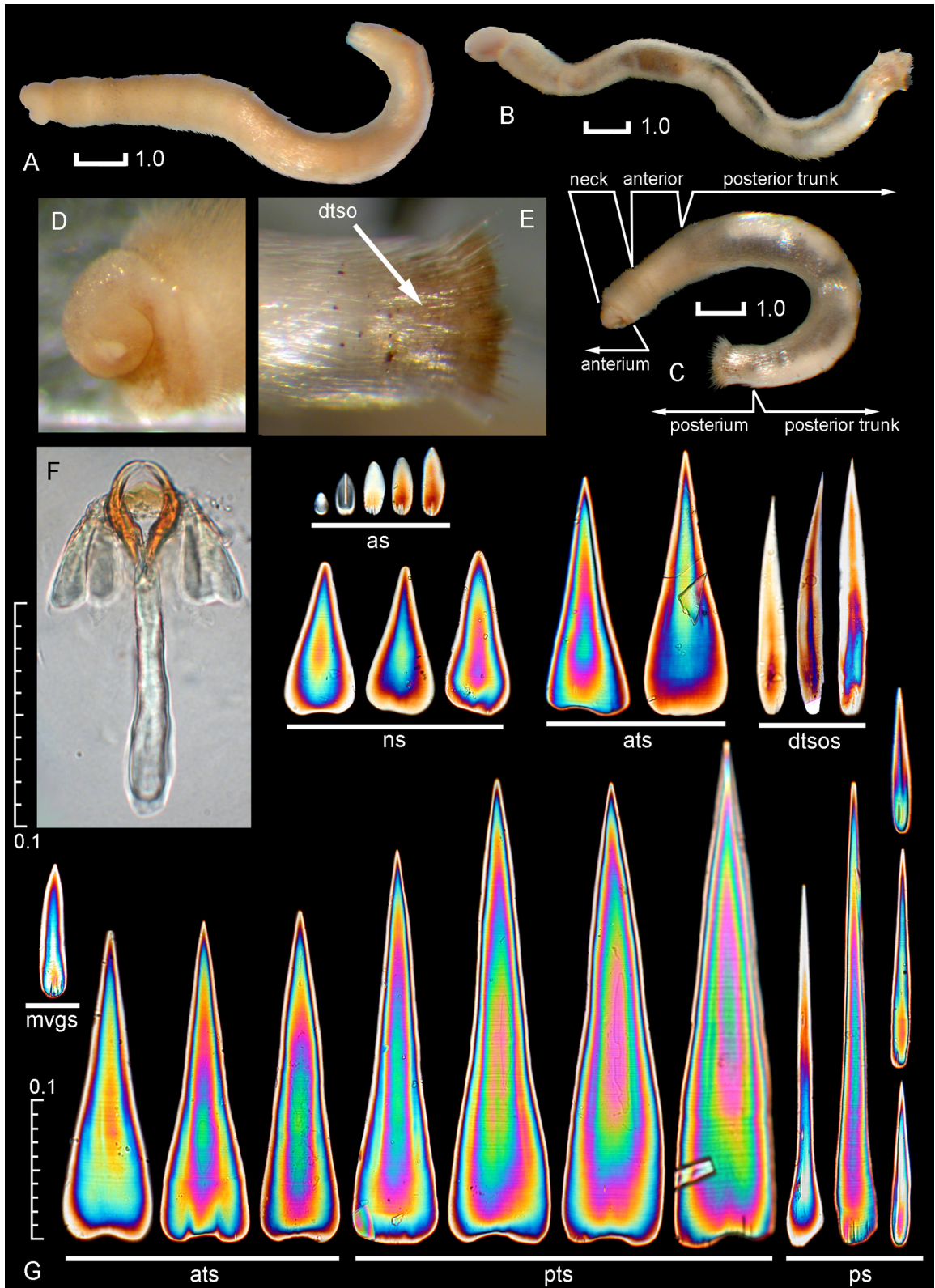


Figure 4. *Falcidens sagittiferus* Salvini-Plawen, 1968. A – holotype (BZM No. 48371); B – living specimen (R/V Hans Brattström); C – specimen B after fixation in alcohol; D – oral shield; E – posterior (*dtso* – dorsoterminal sense organ); F – radula; G – sclerites from: *as* – anterior, *ats* – anterior trunk, *dtsos* – dorsoterminal sense organ, *mvgs* – midventral groove, *ns* – neck, *ps* – posterior, *pts* – posterior trunk (scale bars in mm). Photo: Dimitry L. Ivanov.

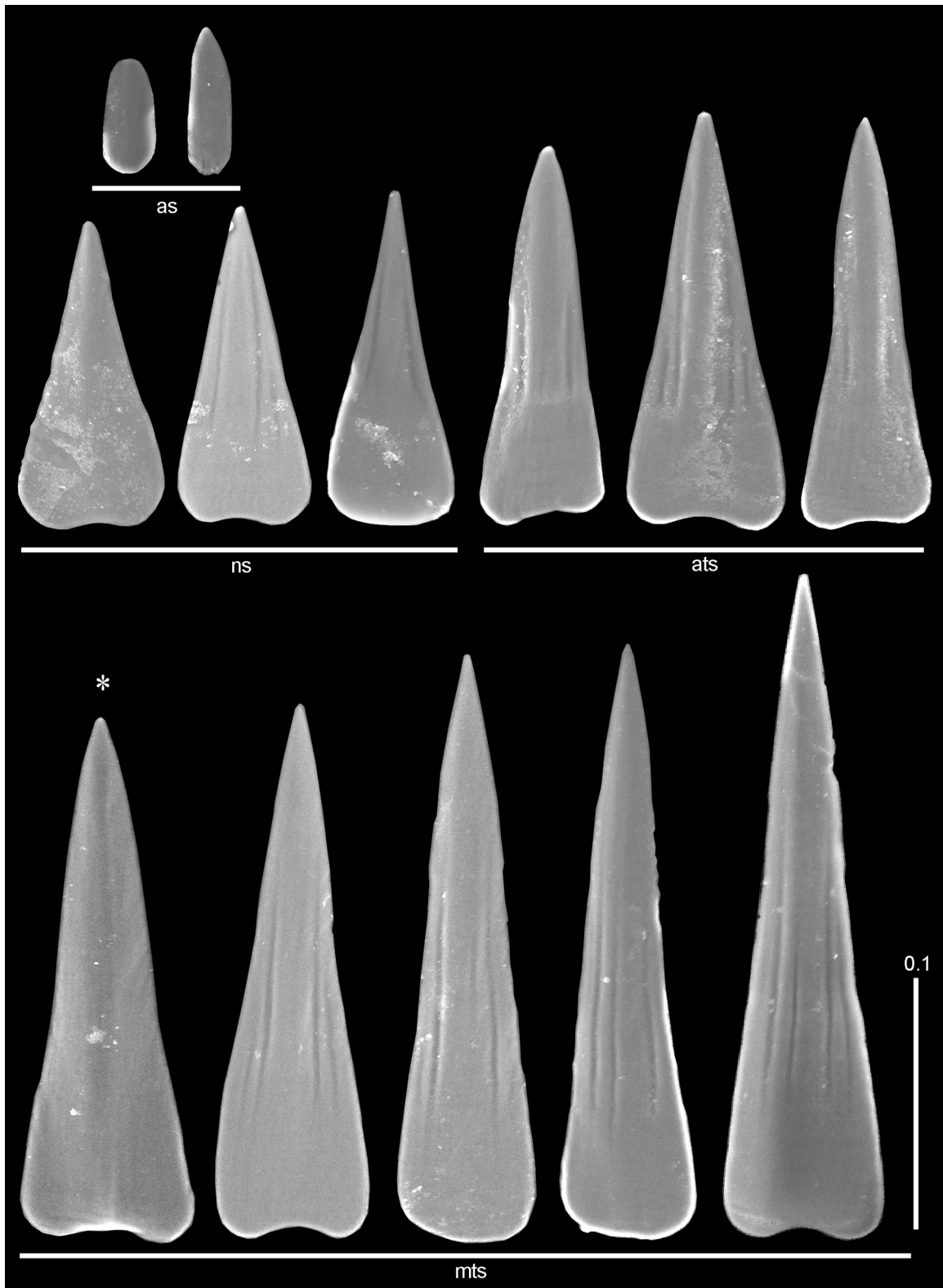


Figure 5. *Falcidens sagittiferus* Salvini-Plawen, 1968 (BIOICE Sta. 3510). Scanning electron micrographs of sclerites from: *as* – anterium, *ats* – anterior trunk, *mts* – midtrunk, *ns* – neck, \* – inner surface of sclerite (scale bar in mm). Photo: Dimitry L. Ivanov.

semi-translucent; ctenidia small, whitish-pink; length 11.4 mm, anterium 0.8 x 0.75 mm, neck 1.5 x 1.0 mm, anterior trunk 1.5 x 0.75 mm, posterior trunk 6.9 x 0.9 mm, posterium 0.7 x 0.8 mm, neck/trunk index 0.18, anterior/posterior trunk index 0.21, posterium/trunk index 0.08.

**Specimen fixed in alcohol** (Fig. 4C): stoutish, 20% shorter and 20% greater in diameter than living specimen (Fig. 4B); length 9.0 mm, anterium 0.4 x 0.6 mm, neck 0.8 x 0.9 mm, anterior trunk 1.15 x 1.0 mm, posterior trunk 6.0 x 1.1 mm, posterium 0.65 x 0.8 mm, neck/trunk index 0.11, anterior/posterior trunk index 0.19, posterium/trunk index 0.09; anterium and neck most contracted regions. Neck and anterior trunk sclerites extending out from body; trunk sclerites flat-lying, parallel to body axis. Midventral groove distinct on anterior trunk with specialized sclerites. Posterior end truncated, ringed by long sclerites. Dorsoterminal sense organ distinct, short (0.4 mm in length), with specialized sclerites (Figs. 2-4).

**Oral shield** (Figs. 2B, 4D): small, horseshoe-shaped, up to 0.3 x 0.5 mm.

**Sclerites** (Figs. 2D, 3C, 4G, 5): from anterium (*as*) symmetrical, scale-shaped, thin, to 50 x 25 x 3 µm, thickest proximally, no waist, no grooves, base narrow; from neck (*ns*) two types, one symmetrical, elongate, with rounded base, waist distinct, blade and base nearly equal in length, thickest basally, to 110 x 30 x 5 µm, the other type broad, triangular, with or without distinct waist, blade equal to or longer than base, thickest medially on blade, proximal end widest, usually indented to 120 x 50 x 7 µm, outer surface with pair of diverged grooves starting from distal point and passing to middle of base, additional lateral grooves can be asymmetrical, distinct near waist (Fig. 5 – *ns*); midventral groove sclerites (*mvgs*) symmetrical, elongate, with narrow, rounded proximal end, without waist, blade shorter and broader than base, central keel distinct, thickest medially on base, to 110 x 30 x 5 µm; anterior trunk sclerites (*ats*) symmetrical, arrow-shaped, with very distinct waist, base short, usually less than 1/3 of total length, indented proximally, width of blade equal to or less than width of base, thickest medially on blade, to 230 x 50 x 9 µm, central keel distinct, two pairs of grooves on outer surface; posterior trunk sclerites (*pts*, *mts*) as in diagnosis, to 280 x 50 x 7 µm, thickest medially on blade, inner surface of sclerite with medial central depression on blade and a pair of lateral depressions on base (Fig. 5 – *mts*\*) (not easily observed), sclerites fringing posterium (*ps*) symmetrical, long, straight, narrow, with distinct waist, blade longer and narrower than base, to 500 x 25 x 9 µm; dorsoterminal sense organ sclerites (*dsos*) elongate, S-shaped, with curved base, waist indistinct, thickest near proximal end, to 150 x 20 x 5 µm. Sclerites of juvenile (6.2 mm in length) and adult (14.5 mm in length) specimens are very similar in shape and dimensions (Figs. 3C, 4D).

**Radula** (5 examined) (Figs. 2C, 3B, 4F): sclerotized sickle-shaped teeth large, to 45-50 µm in length, attached by symphysis to apex of cuticular cone; central plate simple, wider than high, with angular thickened upper edge, to 10 x 30 µm, lateral

membrane paired, short, ratio of membrane length to cuticular cone length 0.5-0.45. Dimensions of cuticular cone increasing from 85 x 30 to 200 x 40 µm in specimens with 6.2 mm and 14.5 mm in length respectively, frontal width about ½ lateral width.

**Remarks:** *F. sagittiferus* shows similarities in body shape to *Scutopus robustus* Salvini-Plawen, 1970 and to some species of Chaetodermatidae inhabiting the same region, but can be easily distinguished by a midventral groove with specialized sclerites on the anterior trunk and by long arrow-shaped sclerites on the posterior trunk.

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## REFERENCES

- Ivanov DL, Scheltema AH. 2001. Distribution of known caudofoveate species (Mollusca, Aplacophora) around Iceland. *Ruthenica* 11(1): 1-6.
- Ivanov DL, Scheltema AH. 2008. Western Atlantic Prochaetodermatidae from 35° N South to the Argentine basin including the Gulf of Mexico (Mollusca: Aplacophora). *Zootaxa* 1885: 1-60.
- Salvini-Plawen L. 1968. Über Lebendbeobachtungen an Caudofoveata (Mollusca, Aculifera) nebst Bemerkungen zum System der Klasse. *Sarsia* 31: 105-126.
- Salvini-Plawen L. 1970. Die norwegischen Caudofoveata (Mollusca, Aculifera). *Sarsia* 45: 1-15.
- Salvini-Plawen L. 1975. Mollusca, Caudofoveata. *Marine Invertebrates of Scandinavia*, No. 4. Oslo. Universitetsforlaget. 55 p.
- Salvini-Plawen L, Warén A. 1972. Skandinavische Caudofoveata (Mollusca): Nachtrag. *Sarsia* 51: 3-6.
- Scheltema AH, Ivanov DL. 2004. Use of birefringence to characterize Aplacophora sclerites. *The Veliger* 47(2): 153-156.