

Three species of Dorvilleidae (Annelida: Polychaeta) associated with Atlantic deep-sea reducing habitats, with the description of *Ophryotrocha fabriae*, new species

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Abstract.—Three deep-sea species of Dorvilleidae are studied. *Ophryotrocha fabriae*, new species, collected at the Lucky Strike hydrothermal vent field (1620–1730 m depth, Mid-Atlantic Ridge), is the first dorvilleid described from Atlantic deep-sea vents. It resembles *O. maciolekae* Hilbig & Blake, 1991, another Atlantic deep-sea species but differs in prostomial and pygidial appendages, chaetae, and maxillae. The second dorvilleid species, collected at the Haakon Mosby Mud Volcano (1258 m, SW Barents sea slope, off Norway), differs only slightly from *O. spatula* Fournier & Conlan, 1994 from Canadian Arctic ice scours and is, therefore, reported as *O. cf. spatula*, being the first *Ophryotrocha* reported from a cold seep site. The third species, sorted from the Menez Gwen hydrothermal vent field samples (840–865 m, Mid-Atlantic Ridge), is reported as *Ophryotrocha* sp., as the material was inadequate for full identification.

Marine annelids of the genus *Ophryotrocha* Claparède & Meczniow, 1869 are opportunists and occur from shallow water to deep-sea areas in reducing and non-reducing habitats (Dahlgren et al. 2001). In shallow water, they have mainly been found in nutrient-rich environments such as polluted harbors (Åkesson 1984, Paavo et al. 2000). They have been reported from deeper water (Jumars 1974, Hilbig & Blake 1991), where some species have been discovered in reducing habitats such as hydrothermal vents (Blake & Hilbig 1990) and cold seeps (Hilbig & Fiege 2001). Thus far, six dorvilleid species, of which four belong to *Ophryotrocha*, have been reported from hydrothermal vents in various types

of habitats such as active smoker walls, sediments saturated with petroleum hydrocarbons and seeps warmed by percolating hot water (Miura 1997, Desbruyères et al. 2006). They have been found associated with other organisms such as siboglinid worms, mussels, clams, or in microbial mats at very high densities (>2000 individuals/m²) (Desbruyères et al. 2006). The only species of Dorvilleidae reported from a cold seep, *Parougia oregonensis* Hilbig & Fiege, 2001, has been collected at the Cascadian Margin off Oregon (600–800 m in the northeast Pacific) (Hilbig & Fiege 2001).

The present paper reports on the specimens of Dorvilleidae collected during four different cruises: DIVANAUT2 (1994), PICO (1998), MOMARETO (2006), and VICKING (2006). The three

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first cruises occurred in the Azores Triple Junction region, Mid-Atlantic Ridge, with PICO and MOMARETO cruises at the 'Eiffel Tower' chimney (Lucky Strike vent field, 37°17.33'N, 32°16.51'W, 1700 m, Langmuir et al. 1997) and DIVANAUT2 at the 'PP11' site (Menez Gwen vent field, 37°51'N, 31°31'W, 840–865 m, Colaço et al. 1998). The fourth cruise, VICKING, explored the Haakon Mosby Mud Volcano (HMMV), a cold methane-venting seep site at the Barents Sea slope, northern North Atlantic (72°00'N, 14°43'E, 1258 m, Vogt et al. 1997). From fauna samples collected during these four cruises, we identified three species of *Ophryotrocha*: two from hydrothermal vents, of which the one found at Lucky Strike vent field is described as a new species, and one from the HMMV cold methane seep.

Materials and Methods

Fauna was sucked or grabbed during the four cruises by the manned submersible *Nautilie* and the ROV *Victor 6000*. On board the ship, specimens were fixed for 24 hours in 10% buffered formalin in seawater and preserved in 70% ethanol. In the laboratory, samples were sorted through a 63 µm mesh sieve. For jaw observations, some specimens were cleared in 10% KOH, others dorsally or ventrally opened with an insect pin mounted on a pin holder. Jaw preparations and entire specimens were critical point dried with carbon dioxide, sputtered with gold, and examined with a FEI scanning electron microscope (Quanta 200). Measurements of the body width were taken at the first chaetiger, excluding chaetae. All drawings were made with a camera lucida. Type material and other specimens are deposited at the Muséum National d'Histoire Naturelle, Paris (MNHN) and the Australian Museum, Sydney (AMS). Terminology of the jaw elements follows Paxton (2004).

Family Dorvilleidae Chamberlin, 1919
Genus *Ophryotrocha* Claparède & Mecznirow, 1869

Ophryotrocha fabriae, new species
Figs. 1–3

Material examined.—Mid-Atlantic Ridge, specimens sorted from sampling at the active 'Eiffel Tower' smoker (Lucky Strike vent field), in habitat dominated by *Bathymodiolus*. Total number of specimens: 278.

Holotype.—37°17.346'N, 32°16.535'W, 1694 m, 1 Sep 2006 (*Victor 6000*, dive 305; MNHN POLY 1489).

Paratypes.—37°17.344'N, 32°16.525'W, 1691 m, 2 Sep 2006 (*Victor 6000*, dive 304; 10, MNHN POLY 1491); 37°17.347'N, 32°16.530'W, 1692 m, 2 Sep 2006 (*Victor 6000*, dive 304; 30, MNHN POLY 1490; 15, AMS W.33872); 37°17.345'N, 32°16.528'W, 1693 m, 3 Sep 2006 (*Victor 6000*, dive 305; 10, MNHN POLY 1493; 9, AMS W.33871); 37°17.346'N, 32°16.535'W, 1694 m, 1 Sep 2006 (*Victor 6000*, dive 305; 5, MNHN POLY 1492; 10, AMS W.33873).

Description.—Length of holotype 1.9 mm for 19 chaetigers, width 0.2 mm; paratypes 1.2–2.5 mm for 9–21 chaetigers, width 0.15–0.30 mm. Color in alcohol opaque white. Body short, rounded, becoming slightly dorsoventrally compressed posteriorly (Figs. 1A, B, 2A). Ciliary bands not observed but indicated by lateral ciliary tufts on prostomium, peristomium, chaetigers, and pygidium (Fig. 2A, C).

Prostomium rounded, about twice as wide as long, bearing pair of simple ovate dorsolateral antennae and shorter ventrolateral palps (Figs. 1A, C, 2A). Eyes and nuchal organs not visible. Peristomium represented by two apodous achaetous rings, similar in length to following chaetigers.

Parapodia uniramous, dorsal cirrus absent but dorsal protrusion with bundle of tactile cirri present, ventral cirrus absent; with triangular acicular lobe and

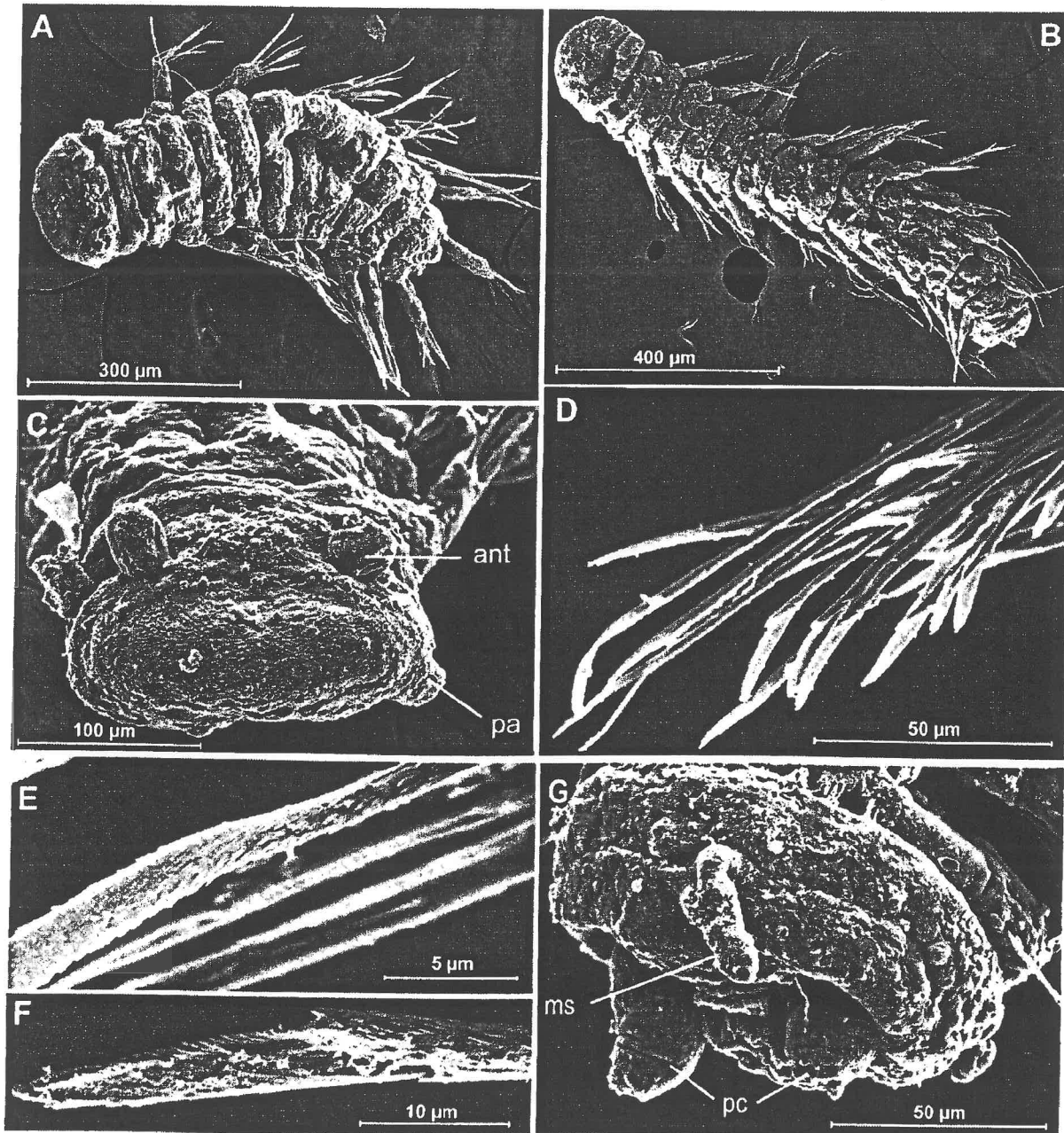


Fig. 1. *Ophryotrocha fabriae*. SEM images. A, anterior end, dorsal view; B, entire specimen, ventral view; C, prostomium, anterodorsal view; D, simple and compound chaetae; E, detail of simple chaeta; F, upper part of heterogomph falciger; G, pygidium, posteroventral view. Abbreviations: ant, antenna; ms, median stylus; pa, palp; pc, pygidial cirri.

ventral retractile lobe supported by short simple chaeta (Fig. 2B). Supra-acicular fascicle with 2 to 5 simple chaetae, subacicular fascicle with 3 to 5 heterogomph falcigers and inferiormost simple chaeta (Figs. 1D, 2B); appendage of falcigers and upper part of simple chaetae finely serrated (Fig. 1E) with single distal tooth (Fig. 1F). Pygidium with pair of

terminal ovate pygidial cirri and one ventral short median stylus; tactile cilia present at posterior margin and at distal tips of pygidial cirri (Figs. 1G, 2C).

Mandibles consisting of two elongate shafts, widening distally into bifid serrated cutting plates with 18–20 tiny pointed teeth at anterior cutting edge of each plate (Figs. 2D, 3A, B). Maxillary

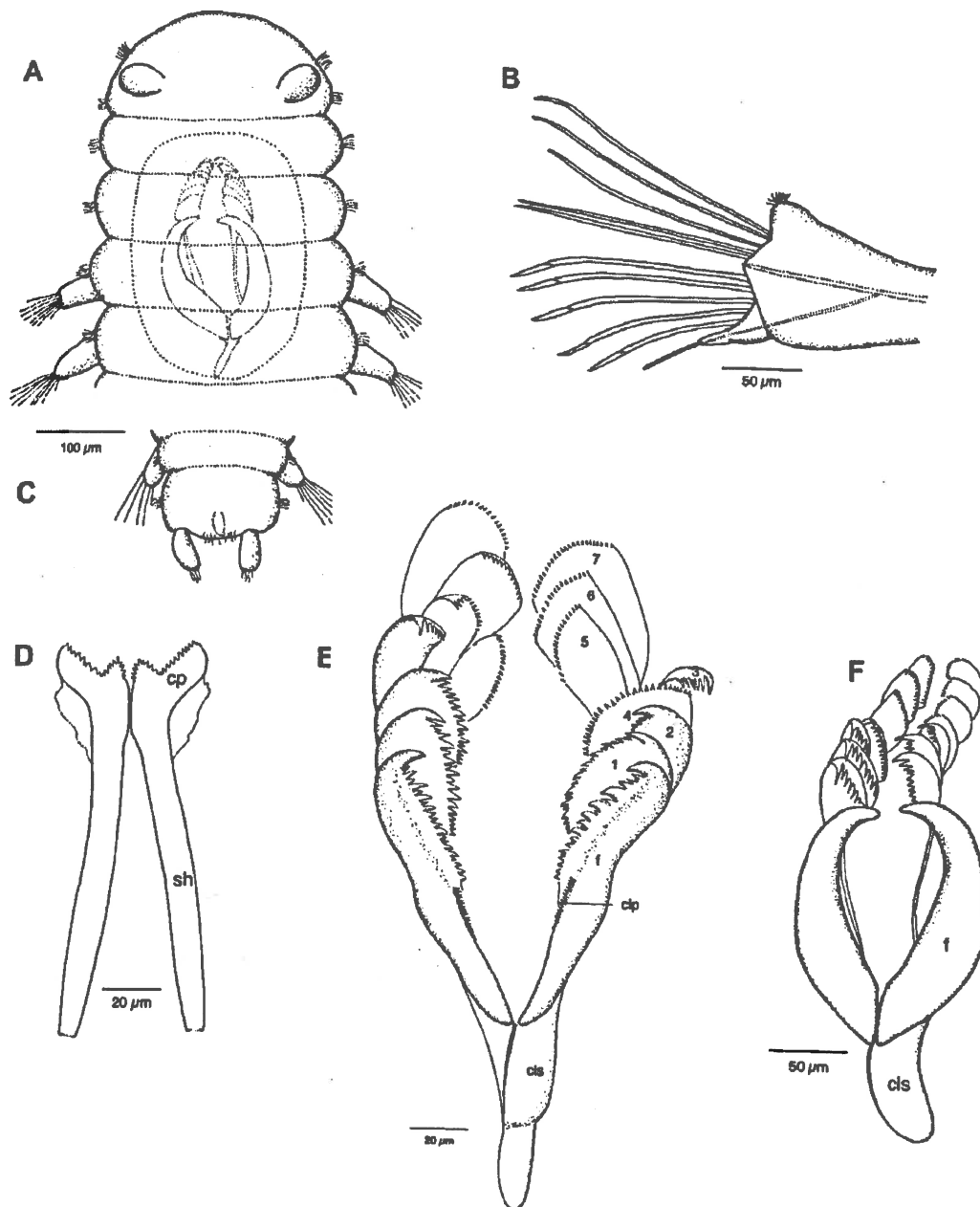


Fig. 2. *Ophryotrocha fabriae*. A, anterior end of 17-chaetiger specimen, dorsal view; B, median parapodium, posterior view; C, posterior end of 17-chaetiger specimen, dorsal view; D, mandibles of 9-chaetiger specimen, ventral view; E, P-maxillae of 16-chaetiger specimen, dorsal view; F, K-maxillae of 19-chaetiger specimen. Numerals refer to free denticles. Abbreviations: clp, comb-like fused plate; cls, carrier-like structure; cp, cutting plate; sh, shaft.

apparatus of P- or K-type; P-type (Figs. 2E, 3C, D) present in smallest to 16-chaetiger specimens, K-type (Fig. 2F) in 15-chaetiger specimens and larger. Maxillae consisting of forceps fused with carrier-like structure and seven pairs of anterior free denticles (D). Median edge of anterior part of P-forceps with large distal fang and serrated by alternating

large and small teeth. Slightly posterior and lateral to serrated edge very finely serrated comb-like plate fused to forceps (Figs. 2E, 3C). D1–D3 with distal fang and coarsely serrated median cutting edge; D4–D7 with finely serrated edge (Figs. 2E, 3D). K-forceps smooth, distally falcate. Free denticles attached by ligament strut to forceps; D1–D3 with

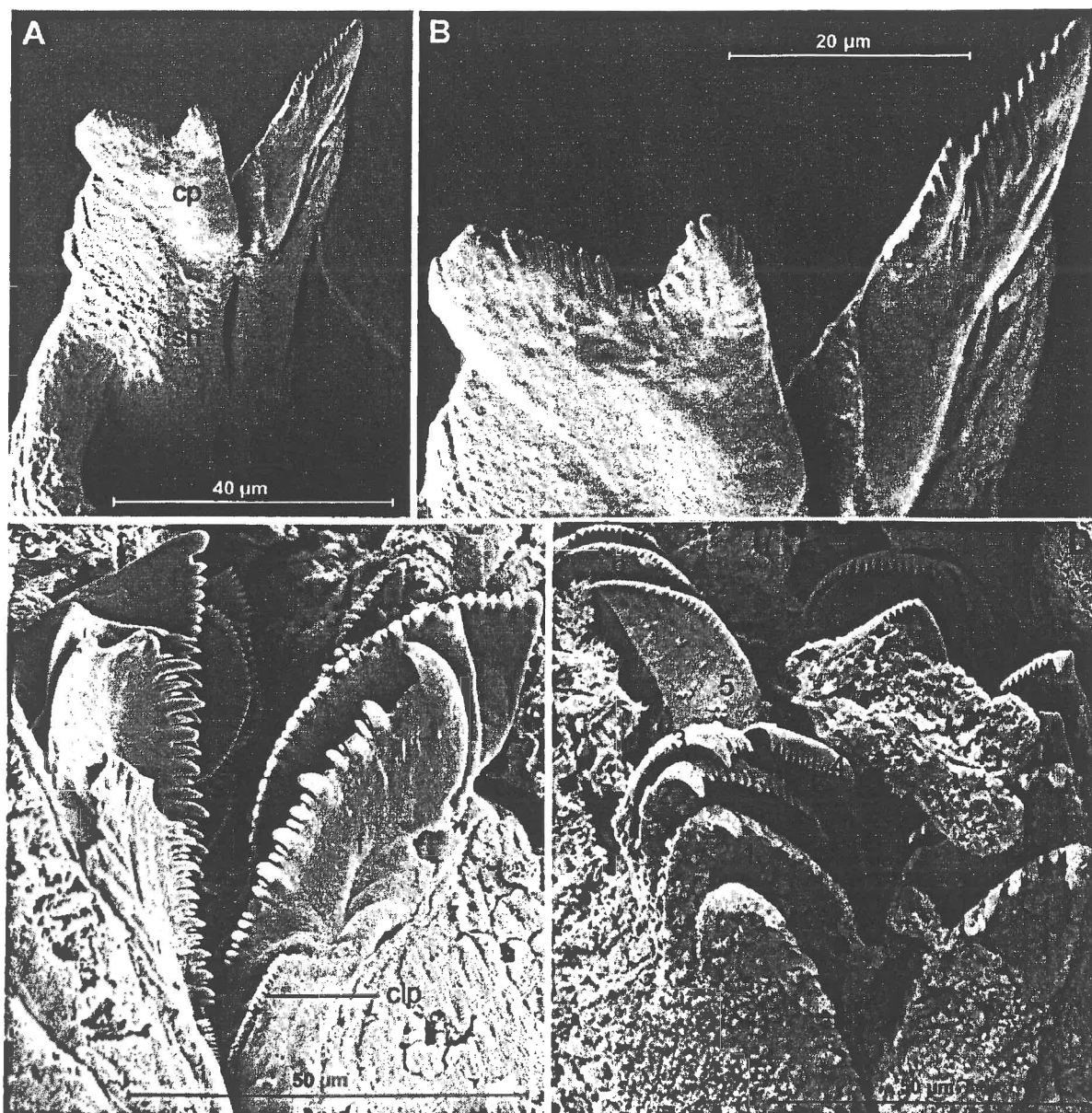


Fig. 3. *Ophryotrocha fabriae*. SEM images. A, mandibles, ventral view; B, same, details of cutting plates; C, P-maxillae, showing forceps and some free denticles, dorsal view; D, P-maxillae, showing upper part of forceps and complete set of 7 free denticles on left side, dorsal view. Numerals refer to free denticles. Abbreviations: clp, comb-like fused plate; cp, cutting plate; f, forceps; sh, shaft.

distal fang and coarsely serrated median cutting edge similar to P-maxillae but D1 with fewer teeth, D4–D7 identical to P-maxillae.

Etymology.—The new species is named in honor of Mrs. Marie-Claire Fabri, for her involvement in deep-sea database development (Biocean) and enthusiasm for deep-sea research.

Remarks.—The new species belongs to the group of *Ophryotrocha* species char-

acterized by having a jaw apparatus consisting of bifurcate mandibles and maxillae of the P- and K-type, where both K-forceps are falcate. This group includes one deep-sea species, *O. maciolekae* Hilbig & Blake, 1991 from the U.S. Atlantic slope and rise and two littoral species, *O. puerilis* Claparède & Meczni-kow, 1869 from the Mediterranean and North Atlantic (Paxton & Åkesson 2007), and *O. adherens* Paavo et al., 2000, from

the Mediterranean, North Atlantic, and Hawaii (Paavo et al. 2000).

Ophryotrocha fabriae differs from *O. maciolekae* in general body form, chaetae, and maxillae. The most important differences are that the former has palps, a median pygidial stylus, finely serrated chaetae with a single distal tooth, and the maxilla D3 has at least six teeth; while the latter lacks palps and a median stylus, the chaetae are smooth and blunt-tipped and the maxilla D3 is fang-like and has only two teeth. *Ophryotrocha fabriae* can be distinguished from the two littoral species by having thick ovate palps and a distinct median stylus as an adult, while in *O. puerilis* and *O. adherens* the palps are slender and digitate and the median stylus is minute in the former and absent in the latter in larger animals.

Distribution and habitat.—To date, *O. fabriae* is found at the 'Eiffel Tower' edifice, Lucky Strike vent field, 1700 m. This edifice, as all Mid-Atlantic Ridge vent sites, is mostly characterized by habitat dominated by *Bathymodiolus* and shrimps. Our specimens have been sampled within *Bathymodiolus* mussel beds habitat at densities reaching 5600 specimens/m², with temperatures from 5 to 6.4°C and pH from 5.78 to 7.01 (Sarrazin & Sarrazin pers. comm.).

Ophryotrocha cf. *spatula* Fournier & Conlan, 1994
Figs. 4–6

Material examined.—SW Barents Sea slope, off Norway, specimens sorted from VICKING cruise samples, Haakon Mosby Mud Volcano (HMMV). Total number of specimens: 62. 72°00.186'N, 14°43.897'E, 1258 m, 4 Jun 2006 (*Victor 6000*, dive 276, microbial mat, HMMV).—6(AMS W.33875); 72°00.186'N, 14°43.901'E, 1258 m, 4 Jun 2006 (*Victor 6000*, dive 276, sediment).—7(AMS W.33876); 72°00.335'N, 14°42.732'E, 1264 m, 6 Jun 2006 (*Victor 6000*, dive 277, *Sclerolinum contortum* Siboglinidae fields).

Description.—Complete specimens ranging from juvenile 1.3 mm long for 6 chaetigers, 0.3 mm wide to adult 6.0 mm long for 35 chaetigers, width 0.6 mm. Color in alcohol opaque white. Body long, dorso-ventrally compressed throughout.

Prostomium anteriorly rounded, about twice as wide as long, bearing pair of simple ovate dorsolateral antennae and equally long ventrolateral palps (Fig. 4A). Eyes and nuchal organs not visible. One complete ciliary band encircling prostomium in front of antennae (ccb, Fig. 4A), two additional incomplete ciliary bands present ventrally behind complete band (icb1, icb2, Fig. 4B). Peristomium represented by two apodous achaetous rings, similar in length to following chaetigers. Both apodous rings as well as chaetigers encircled by cilia (ccb, Fig. 4B).

Parapodia uniramous, small dorsal cirrus present, ventral cirrus not observed; parapodia with triangular acicular lobe and ventral retractile lobe supported by short simple chaeta (Figs. 4D, 5A). Supra-acicular fascicle with 2 to 4 simple chaetae, subacicular fascicle with 3 to 5 heterogomph falcigers (Fig. 4E) and inferiormost simple chaeta; appendages of falcigers of different lengths, appendages of inferior falcigers only half as long as superior ones; falcigers and upper part of simple chaetae finely serrated, with single distal tooth (Fig. 4F). In larger specimens, consisting of over 25 chaetigers, dorsum of posterior 5–10 segments laterally expanded into lobulate flange, with pygidium forming terminal part (Fig. 4C). Pygidium with pair of minute ovate pygidial cirri and one short median stylus; pygidial cirri of smaller specimens terminal (Fig. 4G), those of larger specimens with expanded flange in ventral position.

Mandibles consisting of two elongate shafts, widening distally into bifid serrated cutting plates with 18–20 tiny pointed teeth at anterior cutting edge of each plate (Figs. 5B, 6A). Maxillary apparatus of P-type only. Maxillae consisting of forceps

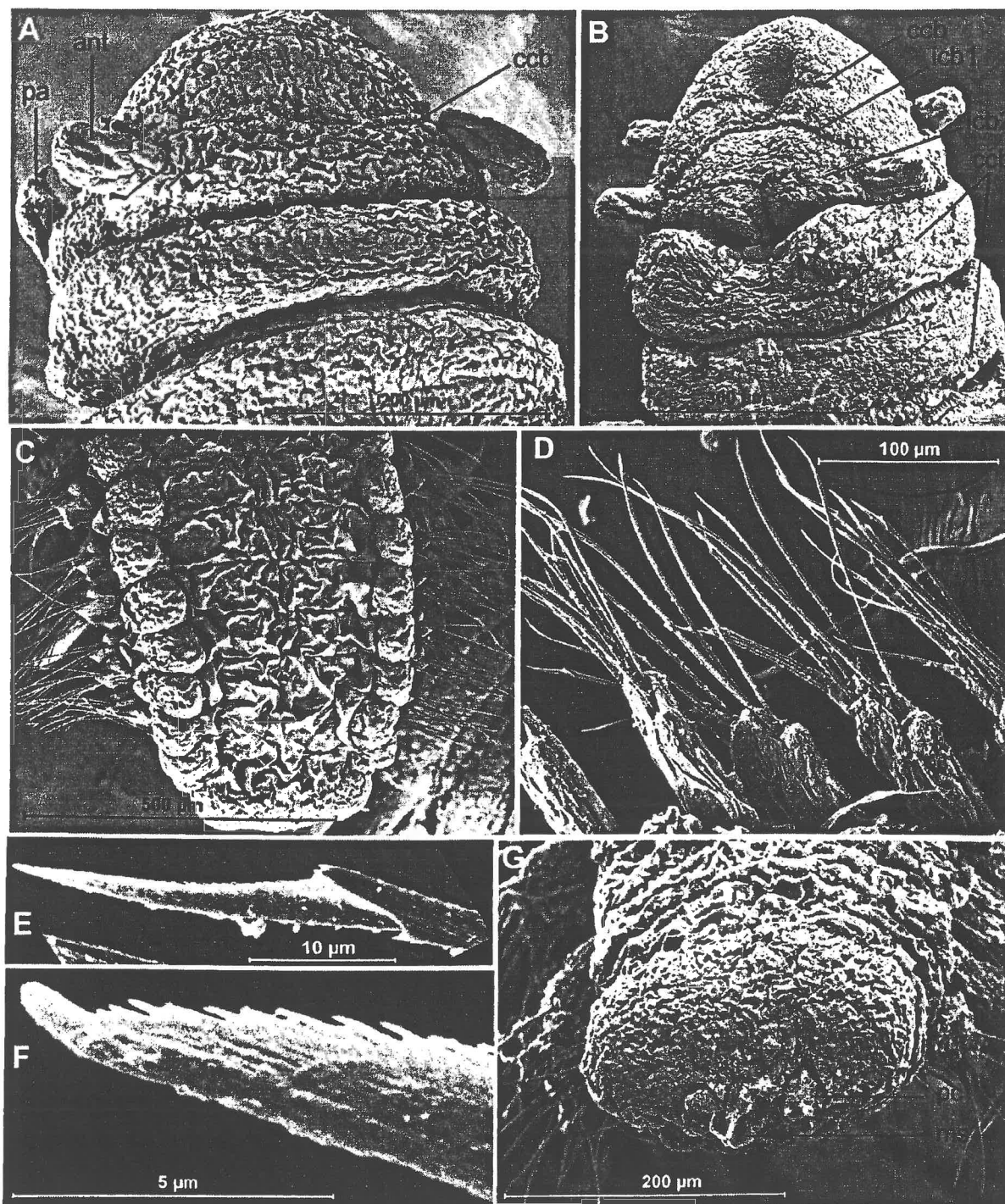


Fig. 4. *Ophryotrocha* cf. *spatula*. SEM images. A, anterior end, dorsal view; B same, ventral view; C, posterior end expanded into lobulate flange, dorsal view; D, parapodia, dorsal view; E, tip of heterogomph falciger; F, same, more enlarged; G, pygidium, posterior view. Abbreviations: ant, antenna; ccb, complete ciliary band; icb, incomplete ciliary band; ms, median stylus; pa, palp; pc, pygidial cirrus.

fused with carrier-like structure and seven pairs of anterior free denticles (Fig. 6B). Median edge of anterior part of P-forceps with large distal fang and serrated by alternating large and small teeth. Posterior

or to distal fang and lateral to serrated edge, a very finely serrated comb-like plate fused to right forceps, slightly lower on left forceps. D1-D3 with distal fang and coarsely serrated median cutting

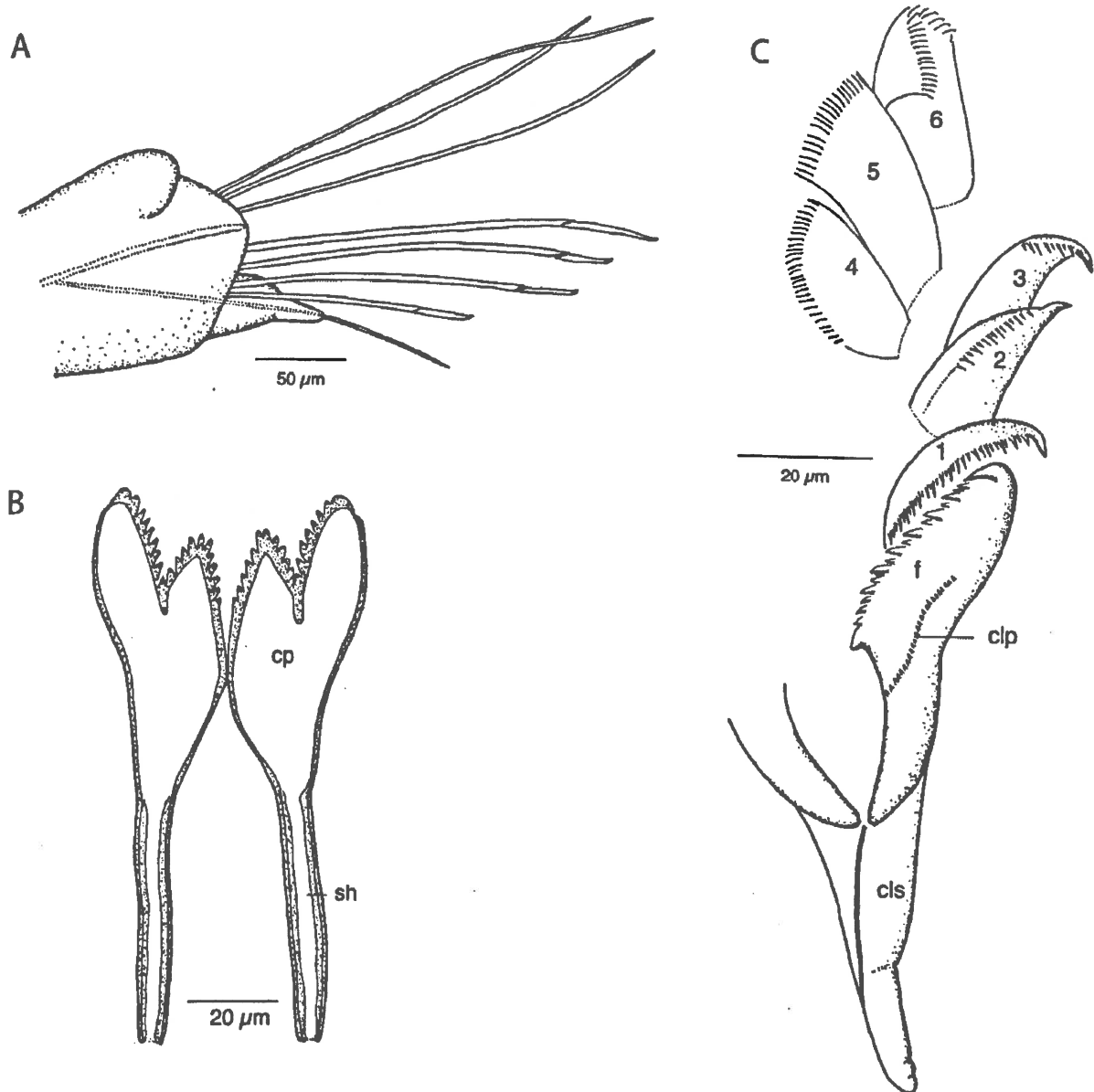


Fig. 5. *Ophryotrocha* cf. *spatula*. A, Median parapodium; B, Mandibles of 6-chaetiger juvenile; C, P1-maxillae of same. Numerals refer to free denticles. Abbreviations: clp, comb-like fused plate; cls, carrier-like structure; cp, cutting plate; f, forceps; sh, shaft.

edge; D4–D7 with finely serrated edge (Fig. 6C).

Remarks.—Our specimens agree in most respects with *O. spatula*, described from ice scours in the Canadian Arctic Archipelago (Fournier & Conlan 1994). The only differences are that in our specimens the posterior dorsal lobulate flange is not as developed and we cannot make out any ventral cirri. Fournier & Conlan (1994) remarked in the original description that the extent of the flange is

variable and cannot be directly related to the size of the animals. They stated that some of the largest specimens showed little expansion, while in smaller ones such as the holotype (32 chaetigers) it was almost double body width. In our specimens it never reaches this size. Even when best developed (in a 34-chaetiger specimen), the flange is only 1.5 times as wide as the body width. In dorsal view the parapodia are covered by the flange but the chaetae are laterally exposed, while in

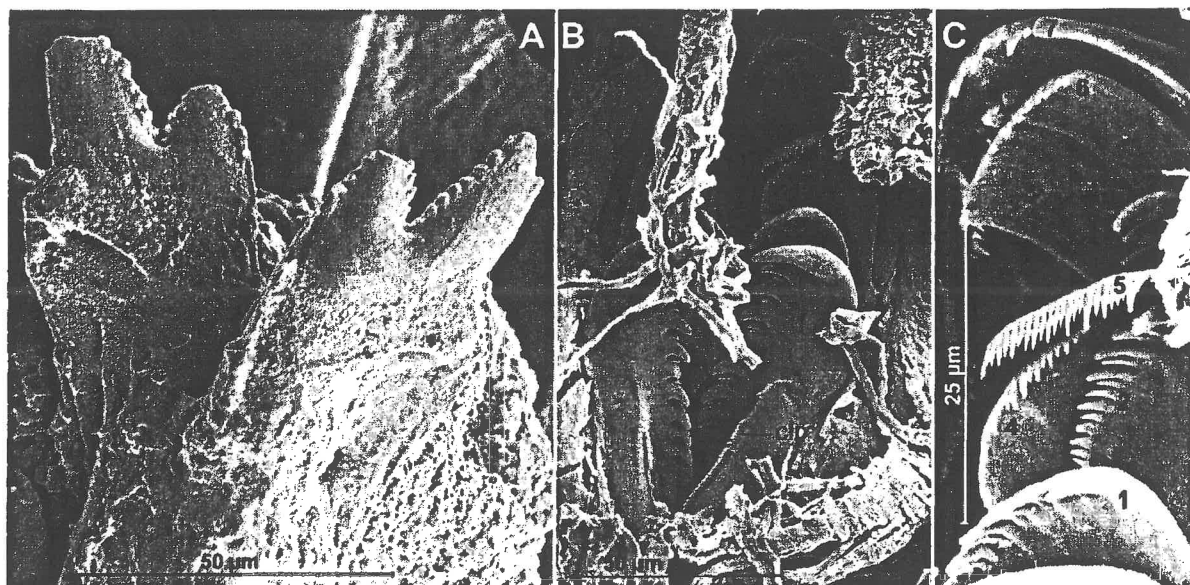


Fig. 6. *Ophryotrocha* cf. *spatula*. SEM images. A, Mandibles, ventral view; B, Maxillae, dorsal view; C, Detail of same showing free denticles. Numerals refer to free denticles. Abbreviations: clp, comb-like fused plate; f, forceps.

the original description the chaetae appear to be covered. Flanges could be reproductive structures, perhaps related to the rosette glands of other species of *Ophryotrocha* that indicate sexual maturity of males and vary with the condition of the individual animal (Paxton & Åkesson 2007). With respect to ventral cirri, Fournier & Conlan (1994) stated that ventral cirri are very difficult to distinguish in anterior chaetigers, but in our specimens they do not appear to be present at all.

In view of the variability of these structures and habitats we consider it prudent to report our specimens as *O. cf. spatula*. This decision is further strengthened since another species with a lobulate flange, *O. scarlatoi* Averincev, 1989, is known from Franz Joseph Land. Although the original description of *O. scarlatoi* is brief and illustrated with simple drawings, the forceps of the maxillary apparatus appear to be of the K-type, which are not found in *O. spatula* or our specimens. Oug (1994) reported *O. cf. scarlatoi* from a soft bottom area near Tromsø, Norway in 7–15 m, which is in geographical proximity

to our collection, albeit from a different habitat. While *O. cf. scarlatoi* is similar to our specimens in lacking K-forceps and ventral cirri, it differs in maxillary and chaetal detail.

Our smallest specimen consisted of six chaetigers only. It had a P1 maxillary apparatus that differs from the adult P2 apparatus by having only six anterior denticles (Fig. 5C). In a study of jaw development of *O. labronica* La Greca & Bacci, 1962, it was shown that P1 jaws were present for a short time only (10–12 days after release from the egg case), in 5- to 8- to 9-chaetiger juveniles (Paxton 2004).

Distribution and habitat.—The specimens were collected at Haakon Mosby Mud Volcano, Barents Sea slope, off Norway from three habitats: *Sclerolinum contortum* Siboglinidae polychaete fields, white microbial mats, and in nearby sediment. If these specimens prove to be conspecific with *O. spatula*, they will have extended the distribution of *O. spatula* from off Cornwallis Island in the Canadian Arctic Archipelago (7–15 m) to Haakon Mosby Mud volcano (840–865 m).

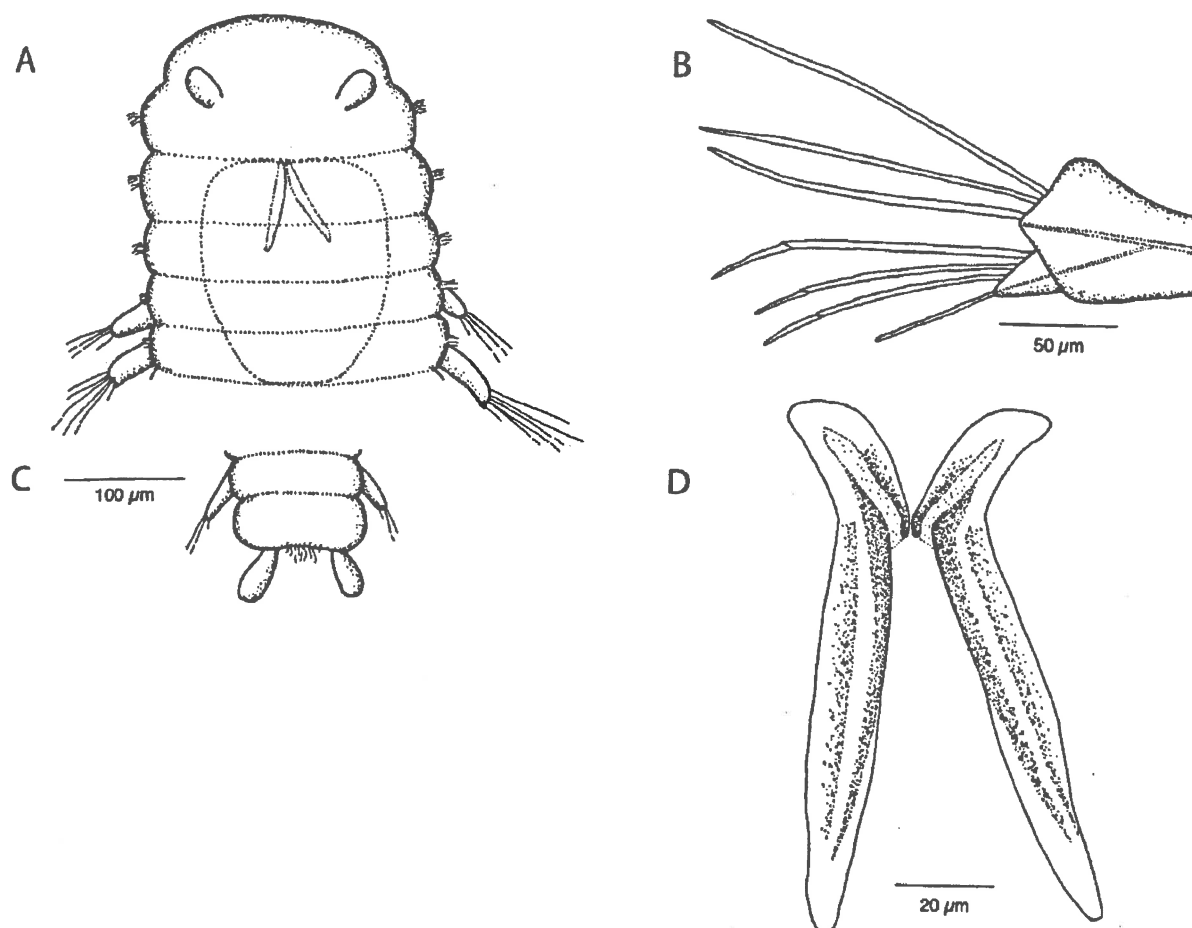


Fig. 7. *Ophryotrocha* sp. A, anterior end, dorsal view; B, median parapodium, posterior view; C, posterior end, dorsal view; D, mandibles, ventral view.

Ophryotrocha sp.
Fig. 7

Material examined.—Mid-Atlantic Ridge, specimens sorted from sampling at the 'PP11' site (Menez Gwen vent field), in habitat dominated by *Bathymodiulus*. Total number of specimens: 6. 37°50.50N, 31°31.40W, 865 m, 14 Jun 1994 (DIVA-NAUT2 cruise, *Nautil*, dive 923, PP11 site).—3 (AMS W.33874).

Description.—Complete specimens ranging from 1.7–2.2 mm long for 16–18 chaetigers, 0.20–0.25 wide. Color in alcohol opaque white. Body short, rounded. Ciliary bands not observed, although lateral ciliary tufts visible on some segments.

Prostomium rounded, about twice as wide as long, bearing pair of simple ovate dorsolateral antennae and smaller ventral

palps (Fig. 7A). Eyes and nuchal organs not visible. Peristomium represented by two apodous achaetous rings, similar in length to following segments with parapodia.

Parapodia uniramous, dorsal cirrus absent but dorsal protrusion present, ventral cirrus absent; with triangular acicular lobe and ventral retractile lobe supported by short simple chaeta. Supracircular fascicle with 2–4 simple chaetae, subacicular fascicle with 3–5 heterogomph falcigers and inferiormost simple chaeta (Fig. 7B); appendage of falcigers and upper part of simple chaetae minutely serrated, with single distal tooth. Pygidium with pair of terminal ovate pygidial cirri (Fig. 7C).

Mandibles consisting of two elongate shafts, distally diverging laterally into

cutting plates with straight cutting edge (Fig. 7D). Mandibular shafts darkly sclerotized, cutting plates very pale, hardly visible. Maxillary apparatus very weakly sclerotized, structure cannot be made out.

Remarks.—This species is characterized by the combination of short body, mandibles with straight cutting edge, and simple inferiormost chaetae. In view of our very limited material and inability to see the entire jaw apparatus, specific identification is not possible until more material becomes available.

Distribution and habitat.—*Ophryotrocha* sp. has been sampled at PP11, Menez Gwen vent field, 850 m, in habitat dominated by *Bathymodiolus*.

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