

Range extension of two deep-sea nudibranchs, *Tritonia newfoundlandica* and *Doridoxa ingolfiana* (Mollusca: Gastropoda: Heterobranchia), in eastern Canada

HEATHER D. PENNEY^{1,*}, JEAN-FRANÇOIS HAMEL², and ANNIE MERCIER¹

¹Department of Ocean Sciences, Ocean Sciences Centre, Memorial University, St. John's, Newfoundland and Labrador A1C 5S7 Canada

²Society for the Exploration and Valuing of the Environment, 21 Phils Hill Road, St. Philips, Newfoundland and Labrador A1M 2B7 Canada

*Corresponding author: hpenney@mun.ca

Penney, H.D., J.-F. Hamel, and A. Mercier. 2020. Range extension of two deep-sea nudibranchs, *Tritonia newfoundlandica* and *Doridoxa ingolfiana* (Mollusca: Gastropoda: Heterobranchia), in eastern Canada. *Canadian Field-Naturalist* 134(2): 165–170. <https://doi.org/10.22621/v134i2.2443>

Abstract

Deep-sea nudibranchs (Mollusca: Gastropoda: Heterobranchia) have rarely been reported from eastern Canada. Here we describe range extensions for two species found in the northwest Atlantic Ocean. *Tritonia newfoundlandica* Valdés, Murillo, McCarthy & Yedinak, 2017 was originally collected on the Flemish Cap off Newfoundland, Canada, and *Doridoxa ingolfiana* Bergh, 1899 was originally found off western Greenland with further records in Iceland, northern Norway, and southeastern Canada. We extend the northern range of *T. newfoundlandica* 1067 km along the eastern coast of North America and add occurrences of *D. ingolfiana* in the Labrador Sea, bridging a 2044 km gap between previous records in Greenland and southern Newfoundland. The latter species thus exhibits a continuous distribution from Svalbard, the Faroe Islands, Greenland, down to the southern tip of the Grand Banks in eastern Canada. *Tritonia newfoundlandica* was collected in its known depth range, whereas the depth distribution of *D. ingolfiana* was extended by 30 m to a maximum depth of 1375 m. Both species were collected with numerous nephtheid corals, suggesting that there may be a functional relationship, where the nudibranchs find refuge or food on them.

Key words: North Atlantic Ocean; Newfoundland and Labrador; sea slug; Tritoniidae; Doridoxidae; biodiversity; taxonomy; *Tritonia newfoundlandica*; *Doridoxa ingolfiana*

Introduction

Members of the dendronotid nudibranch family Tritoniidae (Menke, 1828) are grouped into 11 genera and over 80 species, many occurring worldwide. One of the most recently described species, *Tritonia newfoundlandica* Valdés, Murillo, McCarthy & Yedinak, 2017 (no common name) was found off the southern coast of Newfoundland (eastern Canada) and is represented by 62 records to date. Most of the records ($n = 57$) were reported by Valdés *et al.* (2017), and the rest are from Svalbard, Norway (Zakharov and Jørgensen 2017).

Doridoxid nudibranchs are rare: the family Doridoxidae (Bergh, 1899) comprises a single genus and only three species: *Doridoxa benthalis* Barnard, 1963, *Doridoxa ingolfiana* Bergh, 1899, and *Doridoxa walteri* (Krause, 1892) (MolluscaBase 2020; no common names). Before our study, 25 individuals had

been documented, 15 of which were *D. ingolfiana*. Individuals of *D. benthalis* were collected in deep waters (~2300 m) of the southern Atlantic Ocean off South Africa (Barnard 1963). The two original specimens of *D. ingolfiana* were collected off western Greenland in the North Atlantic Ocean during the Danish Ingolf Expedition over a century ago (Bergh 1900). Bergh named the larger specimen *D. ingolfiana* and considered the smaller one a “variant”. In 1970, another specimen was collected south of Greenland (Just *et al.* 1985). The third species, *D. walteri*, occurs in Norwegian, Russian, and adjacent waters. It was originally placed in the genus *Dermatobranchus*, but was recently moved to *Doridoxa* (Kantor and Syzoev 2006). Very little is known about its biology.

We add new records of *T. newfoundlandica* and *D. ingolfiana* from the continental slope of Labrador and the Grand Banks of Newfoundland (eastern Canada).

Methods

During scientific expeditions led by Fisheries and Oceans Canada, multispecies surveys were conducted annually on CCGS *Teleost* between September and December, 2006–2015 (see Power *et al.* 2016 and references therein). Surveys followed a random stratified sampling design, where each set deployed a Campelen 1800 trawl that was towed for 15 min (~1.4 km), with the net opening and closing at depth (~500–1500 m). Although the trawl was not designed to target small benthic organisms, several from a variety of phyla, including gastropod molluscs, were collected as bycatch. Species collected in the same trawls (e.g., sponges, corals) were also noted. Some of the nudibranchs collected in these surveys ($n = 5$) were preserved in 4% formalin, whereas samples from 2011 and 2013 were frozen at -20°C . Three other individuals were kept alive for study.

The preserved specimens were examined under a dissecting microscope (M205A, Leica Microsystems, Singapore) and photographed (microscope camera DFC7000T, Leica Microsystems, Wetzlar, Germany). Identification was based on colour, size, general appearance, and more specific external morphological characteristics in preserved specimens (including the penis, secondary gills, rhinophores, renal and anal pores, and dorsum), as well as on some internal characters, mainly the radula, using descriptions from Valdés *et al.* (2017) for *T. newfoundlandica* and from Schrödl *et al.* (2001) and Valdés *et al.* (2017) for *D. ingolfiana*. Voucher specimens of *T. newfoundlandica* ($n = 1$) and *D. ingolfiana* ($n = 1$) were deposited at the Canadian Museum of Nature, Ottawa (catalog numbers CMNML 2020-0001 and CMNML 2020-0002, respectively). The remaining preserved specimens were kept and stored in the Mercier Lab collection, Ocean Sciences Centre, Memorial University (Newfoundland and Labrador, Canada).

A literature search was conducted to locate all records of *T. newfoundlandica* and *D. ingolfiana*. Data on geographic distributions and depth ranges were summarized. Records were mapped using ggplot2 in R (v. 4.0.2; R Development Core Team 2015).

Results and Discussion

Of the 231 deep-sea trawls conducted between the northern Labrador coast and the southern section of the Grand Banks, 10 sets contained nudibranchs (from depths ranging between 930 and 1375 m; Table 1). Several of the nudibranch specimens were collected on or together with bathyal nephtheid corals, i.e., *Duva florida* (Flowery Carnation Coral), *Gersemia fruticosa* (Hedge Carnation Coral), and *Drifa glomerata* (Orb Carnation Coral). García-Matucheski and Muniaín (2011) showed evidence of *Tritonia* species

feeding on nephtheid corals (including *G. fruticosa*), which could support the hypothesis that *T. newfoundlandica* and *D. ingolfiana* also feed on them.

Specimens of *T. newfoundlandica* ($n = 5$) were black (Figure 1a–e) with 10 pairs of reddish-brown (on live specimens) secondary gills on the fringes of the dorsal body wall (Figure 1a,b), which faded to yellowish brown after preservation. Preserved specimens had an elongate body, a rounded anterior end, and a pointed posterior end (Figure 1a) as described by Valdés *et al.* (2017). Specimens had perfoliated rhinophores with six branched vertical lamellae and rhinophoral sheaths (Figure 1a,c,d), and an undivided oral veil bearing 10 simple, tentacular processes (Figure 1d). The right, lateral side of the body had a renal and anal pore, as well as the genital opening with a penis (finishing like an arrow or looking short and straight) visible in some specimens (Figure 1a,c). The penis features provided key support for the identification of this species, as mentioned by Valdés *et al.* (2017). The dorsum was smooth and lacking tubercles (Figure 1a). Total body lengths (mean 37 mm, range 26–45 mm) were within the previously documented range (20–60 mm; Valdés *et al.* 2017). One specimen of *T. newfoundlandica* possessed a well-developed whitish female gland complex, which was visible through the body wall (Figure 1e).

Doridoxa ingolfiana ($n = 7$) were ovate with a broader anterior end (Figure 1f,g). They had perfoliated rhinophores with sheaths (Figure 1f), and the genital openings, anal pore, and renal pore were exclusively on the right side of the body (Figure 1h). The penis was large, wide, smooth, had a general mushroom-like appearance at the tip, and was the same colour as the rest of the body (Figure 1g,h). This species did not exhibit oral veil papillae or secondary gills, consistent with descriptions by Schrödl *et al.* (2001) and Valdés *et al.* (2017). Although most of the specimens had papillae on the dorsum, one did not (Figure 1f); this is perhaps an artifact of long-term preservation. Schrödl *et al.* (2001) noted that papillae were occasionally lacking. The anal and renal pores were located posteriorly on the right side of the body (Figure 1h), as mentioned by Valdés *et al.* (2017). One specimen, at 39 mm total length, exceeded the previously reported maximum of 30 mm for all other specimens (Table 1). The colours of the current individuals were also lighter (beige, yellowish, or light pink) than the deep reddish brown described in Valdés *et al.* (2017). Likewise, the specimens found in Norway (Ringvold 2008; Evertsen and Bakken 2013) showed similar light-yellow colours. This suggests that this species displays colour variations that may be genetic or phenotypically plastic, based on environment or diet.

These new records extend the geographic distri-

TABLE 1. Specimen and observational reports of *Tritonia newfoundlandica* and *Doridoxa ingolfiana*.

Report	Date	Location	Latitude, °N	Longitude, °	Depth, m	<i>n</i>	Total length, mm	Source
<i>T. newfoundlandica</i>								
Existing	26 June 2007	Off NFL	46.4487	44.2460 W	492–538	1	38	Valdés <i>et al.</i> 2017
	29 June 2007	Off NFL	46.7468	43.8828 W	480–471	2	45–60	Valdés <i>et al.</i> 2017
	3 July 2007	Off NFL	48.0260	43.2692 W	596–599	1	51	Valdés <i>et al.</i> 2017
	17 July 2007	Off NFL	46.8870	42.6087 W	1242–1245	3	30–49	Valdés <i>et al.</i> 2017
	17 July 2007	Off NFL	46.8873	42.5118 W	1083–1094	6	26–39	Valdés <i>et al.</i> 2017
	17 July 2007	Off NFL	47.0463	42.3430 W	759–764	1	47	Valdés <i>et al.</i> 2017
	5 Aug. 2008	Off NFL	46.7150	45.0680 W	1232	2	26–27	Valdés <i>et al.</i> 2017
	5 June 2009	Off NFL	48.0005	42.2393 W	1554–1607	1	50	Valdés <i>et al.</i> 2017
	14 June 2009	Off NFL	47.1643	42.5331 W	1132–1137	4	34–42	Valdés <i>et al.</i> 2017
	15 June 2009	Off NFL	47.0722	42.5509 W	1113–1122	11	30–37	Valdés <i>et al.</i> 2017
	16 June 2009	Off NFL	46.8461	42.2824 W	870–871	2	26–35	Valdés <i>et al.</i> 2017
	17 June 2009	Off NFL	46.8400	42.3596 W	856–943	2	34–40	Valdés <i>et al.</i> 2017
	18 June 2009	Off NFL	46.7749	42.1349 W	1108–1127	18	23–38	Valdés <i>et al.</i> 2017
	19 June 2009	Off NFL	46.6942	42.0314 W	1104–1112	3	30–35	Valdés <i>et al.</i> 2017
	11 Aug. 2011	Svalbard	78.5672	9.0692 E	578	2	20–30	Zakharov and Jørgensen 2017
	1 Sept. 2014	Svalbard	78.5853	9.1353 E	510–521	3	20–30	Zakharov and Jørgensen 2017
New	Oct. 2007	East of NFL	45.9005	56.3620 W	930	1	45	Our study*
	Nov. 2008	Off Labrador	51.6141	50.7598 W	1324	1	35	Our study
	Nov. 2009	Off Labrador	56.4581	55.8019 W	1212	1	26	Our study
	Sept. 2010	Off Labrador	52.7167	52.2333 W	1111	1	38	Our study
	Dec. 2014	Off Labrador	57.6240	56.6186 W	1198	1	41	Our study
<i>D. ingolfiana</i>								
Existing	12 June 2006	Off NFL	43.0807	50.9988 W	290–300	1	26	Valdés <i>et al.</i> 2017
	19 June 2007	Off NFL	45.8137	47.7428 W	119–120	1	23	Valdés <i>et al.</i> 2017
	29 June 2007	Off NFL	46.7468	43.8828 W	471–480	2	25–27	Valdés <i>et al.</i> 2017
	17 July 2007	Off NFL	46.8873	42.5118 W	1083–1094	2	15–27	Valdés <i>et al.</i> 2017
	9 Aug. 2007	Off NFL	46.0690	45.0008 W	1357–1358	2	28–30	Valdés <i>et al.</i> 2017
	10 Aug. 2008	Off NFL	46.1588	47.9140 W	110–114	1	18	Valdés <i>et al.</i> 2017
	18 June 2009	Off NFL	46.7749	42.1349 W	1108–1127	2	11–23	Valdés <i>et al.</i> 2017
	N/A	Faroe Islands	62.4987	7.3869 W	603	1	N/A	Sneli <i>et al.</i> 2005
	N/A	W. Greenland	65.2833	53.7167 W	100	1	12	Bergh 1899
	21 Oct. 2005	N. Norway	69.3762	15.7306 E	881–907	1	11	Evertsen and Bakken 2013
	5 Oct. 2005	N. Norway	70.1183	17.1138 E	493–503	1	7	Evertsen and Bakken 2013
New	Nov. 2006	South of NFL	51.2500	41.1167 W	1250	1	22	Our study†
	Dec. 2006	South of NFL	51.0167	41.2667 W	1375	2	31–39	Our study
	Nov. 2009	Off Labrador	56.4581	55.8019 W	1212	1	19	Our study
	Nov. 2012	Off Labrador	54.9745	54.6517 W	960	2	18–24	Our study
	Nov. 2015	Off Labrador	52.3791	52.4372 W	1002	1	30	Our study

Note: N/A = not available, NFL = Newfoundland, Canada.

*Voucher specimen at Canadian Museum of Nature: CMNML 2020-0001.

†Voucher specimen at Canadian Museum of Nature: CMNML 2020-0002.

butions of *T. newfoundlandica* (Figure 2a) and *D. ingolfiana* (Figure 2b). The North American range of *T. newfoundlandica* is extended by 9.6° (1067 km north)

into the Labrador Sea. *Doridoxa ingolfiana* has historically been reported south of Newfoundland (Valdés *et al.* 2017) and off western Greenland (Schrödl *et al.*

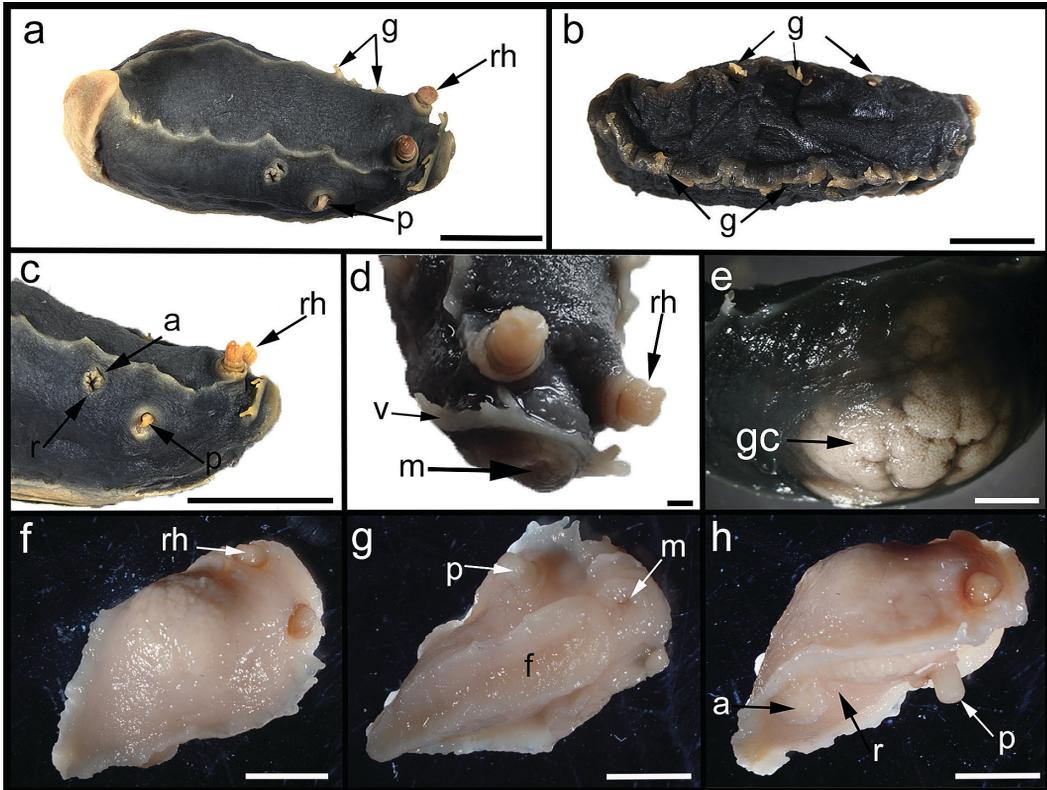


FIGURE 1. The nudibranchs, *Tritonia newfoundlandica* (a–e) and *Doridoxa ingolfiana* (f–h), collected near Newfoundland, Canada. a. General view; b. Dorsal view; c. Lateral view of anterior end; d. Head; e. Lateral view, showing mid-body with whitish female gland complex; f. Dorsal view; g. Ventral view; and h. Lateral view. Scale bars represent 1 cm, except for panel c (1 mm) and panel e (5 mm). Labels: a = anal pore, f = foot, g = secondary gill, gc = gland complex, m = mouth, p = penis, r = renal pore, rh = rhinophore, v = velar appendages. Photos a–d: H.D. Penney. Photos e–h: J.-F. Hamel.

2001), regions separated by 18.4° (2044 km north–south). The current samples demonstrate that the range of *D. ingolfiana* is likely continuous from at least Greenland to southern Newfoundland and extend the species maximum depth to 1375 m.

Recent work on other Cladobranchia nudibranchs in the genera *Coryphella*, *Flabellina* (Korshunova *et al.* 2017a), and *Zeusia* (Korshunova *et al.* 2017b) has revealed cryptic species in each genus. Our study suggests that the distribution of both species is extensive. Consequently, future work should examine genetic differences across latitudes for both *T. newfoundlandica* and *D. ingolfiana* to determine population structure, connectivity, and perhaps assess whether colour and morphological differences may reflect the presence of cryptic species, as already suggested in the *Tritonia* genus by Valdés *et al.* (2018).

Author Contributions

Writing – Original Draft: H.D.P. and J.-F.H.; Writing – Review & Editing: H.D.P., J.-F.H., and A.M.;

Conceptualization: J.-F.H. and A.M.; Investigation: H.D.P. and J.-F.H.; Methodology: H.D.P. and J.-F.H.; Formal Analysis: H.D.P. and J.-F.H.; Funding Acquisition: A.M.

Acknowledgements

We thank the technicians of Fisheries and Oceans Canada as well as the crew of CCGS *Teleost* for their help during these benthic surveys and, more precisely, Philip Sargent for the collection of some nudibranchs. Thanks also to two anonymous reviewers for comments on an earlier version of the manuscript. This research was supported by grants from the Canada Foundation for Innovation and the Natural Sciences and Engineering Research Council of Canada to A.M.

Literature Cited

Barnard, K.H. 1963. Deep sea Mollusca from west of Cape Point, South Africa. *Annals of the South African Museum* 46: 407–452. Accessed 30 July 2020. <https://www.biodiversitylibrary.org/item/127021>.

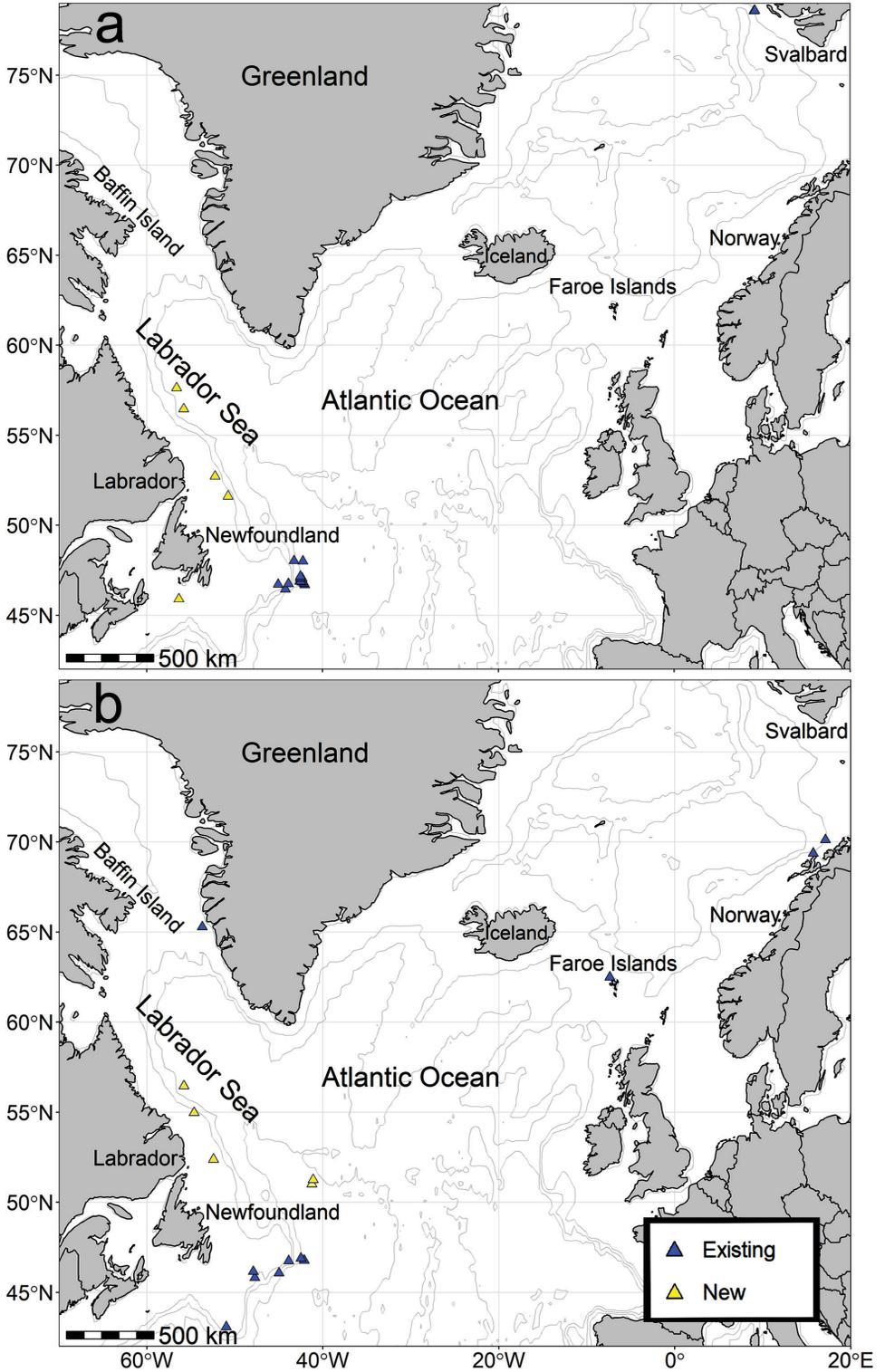


FIGURE 2. Map of existing and new records of a. *Tritonia newfoundlandica* and b. *Doridoxa ingolfiana*.

- Bergh, R.** 1900. Nudibranchiate Gasteropoda. Volume 2, part 3 in *The Danish Ingolf-Expedition*. Bianco Luno, Copenhagen, Denmark. Accessed 30 July 2020. <https://www.biodiversitylibrary.org/item/18830>.
- Evertsen, J., and T. Bakken.** 2013. Diversity of Norwegian sea slugs (Nudibranchia): new species to Norwegian coastal waters and new data on distribution of rare species. *Fauna Norvegica* 32: 45–52.
- García-Matucheski, S., and C. Muniain.** 2011. Predation by the nudibranch *Tritonia odhneri* (Opisthobranchia: Tritoniidae) on octocorals from the South Atlantic Ocean. *Marine Biodiversity* 41: 287–297. <https://doi.org/10.1007/s12526-010-0063-y>
- Just, H., M. Edmunds, and E. Platts.** 1985. North Atlantic nudibranchs (Mollusca) seen by Henning Lemche with additional species from the Mediterranean and the North East Pacific. Appendix: an annotated list of the North Atlantic Opisthobranchia. *Ophelia Supplement* 2: 1–170. Accessed 30 July 2020. <http://www.vliz.be/en/imis?refid=75536>.
- Kantor, Y.L., and A.V. Syzoev.** 2006. *Marine and Brackish Water Gastropoda of Russia and Adjacent Countries: an Illustrated Catalogue*. KMK Scientific Press, Moscow, Russia.
- Korshunova, T., A. Martynov, T. Bakken, J. Evertsen, K. Fletcher, I.W. Mudianta, H. Saito, K. Lundin, M. Schrödl, and B. Picton.** 2017a. Polyphyly of the traditional family Flabellinidae affects a major group of Nudibranchia: aeolidacean taxonomic reassessment with descriptions of several new families, genera, and species (Mollusca, Gastropoda). *ZooKeys* 717: 1–139. <https://doi.org/10.3897/zookeys.717.21885>
- Korshunova, T., O. Zimina, and A. Martynov.** 2017b. Unique pleuroproctid taxa of the nudibranch family Aeolidiidae from the Atlantic and Pacific Oceans, with description of a new genus and species. *Journal of Molluscan Studies* 83: 409–421. <https://doi.org/10.1093/mollus/eyx036>
- MolluscaBase.** 2020. *Doridoxa* Bergh, 1899. World Register of Marine Species, Ostend, Belgium. Accessed 30 July 2020. <http://www.marinespecies.org/aphiaph?p=taxdetails&id=370548>.
- Power, D., D. Ings, R. Rideout, and B.P. Healey.** 2016. Performance and description of Canadian multi-species bottom trawl surveys in NAFO subarea 2 + divisions 3KLMNO, with emphasis on 2014–2015. Document 16/28. Northwest Atlantic Fisheries Organization, Dartmouth, Nova Scotia, Canada.
- R Development Core Team.** 2015. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna.
- Ringvold, H.** 2008. Ny nakensnegl funnet langs norskekysten. Mareano, Norway. Accessed 30 July 2020. https://www.mareano.no/nyheter/nyheter_2008/naken_snegl.
- Schrödl, M., H. Wägele, and R.C. Willan.** 2001. Taxonomic redescription of the Doridoxidae (Gastropoda: Opisthobranchia), an enigmatic family of deep water nudibranchs, with discussion of basal nudibranch phylogeny. *Zoologischer Anzeiger* 240: 83–97. <https://doi.org/10.1078/0044-5231-00008>
- Sneli, J.-A., T. Schiøtte, K. Jensen, P.B. Wikander, Ø. Stokland, and J. Sørensen.** 2005. The marine Mollusca of the Faroes. *Annales societatis scientiarum Færoensis*. 42(suppl.): 1–190.
- Valdés, Á., L. Lundsten, and N.G. Wilson.** 2018. Five new deep-sea species of nudibranchs (Gastropoda: Heterobranchia: Cladobranchia) from the Northeast Pacific. *Zootaxa* 4526: 401–433. <https://doi.org/10.11646/zootaxa.4526.4.1>
- Valdés, Á., F.J. Murillo, J.B. McCarthy, and N. Yedinak.** 2017. New deep-water records and species of North Atlantic nudibranchs (Mollusca, Gastropoda: Heterobranchia) with the description of a new species. *Journal of the Marine Biological Association of the United Kingdom* 97: 303–319. <https://doi.org/10.1017/S0025315416000394>
- Zakharov, D.V., and L.L. Jørgensen.** 2017. New species of the gastropods in the Barents Sea and adjacent waters. *Russian Journal of Biological Invasions* 8: 226–231. <https://doi.org/10.1134/S2075111717030146>

Received 17 February 2020

Accepted 29 July 2020

Associate Editor: D.F. McAlpine