# A NEW SPECIES OF ENDOPARASITIC MOLLUSC FROM THE ARCTIC (GASTROPODA: EULIMIDAE)

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*Abstract* *The shell-less gastropod* Entocolax olgae *sp. n., an endoparasite of the holothurian* Myriotrochus rinkii *Steenstrup, 1851, is described from two localities in the eastern part of the Laptev Sea.* Entocolax olgae *has a deep longitudinal fold in the intestine, a unique feature differentiating it from all other known members of the genus. There are also some differences in the reproductive system and siphon structure. Taxonomically significant morphological features of other* Entocolax *Voigt, 1888 species known from Eurasian seas are also reviewed.*

*Key words* *Eulimidae,* Entocolax, *Arctic, parasite, new species*

## INTRODUCTION

Molluscs of the genus *Entocolax* Voigt, 1888 are a poorly known group of marine molluscs with a morphology that is very unusual within the Gastropoda. Adult *Entocolax* are shell-less and characterized by reduction or significant transformation of their viscera. All species live in the coelomic cavity of sea cucumbers in the families Myriotrochidae Théel, 1887 and Chiridotidae Östergren, 1898. Dwarf-males of *Entocolax* live in the bodies of females.

Until now, only two of the approximately six *Entocolax* species, *E. ludwigii* Voight, 1988 and *E. schwanwitschi* Heding in Heding and Mandahl-Barth, 1938, have been found in the Arctic basin (Heding & Mandahl-Barth, 1938). The majority of species are known only by material used for original descriptions and were not individually reviewed in taxonomical revisions of the family Eulimidae nor identified during numerous faunistic studies of Arctic or adjacent regions.

Recent investigation in the Laptev Sea led to the discovery of a previously unknown *Entocolax* species with a specifically distinct intestine anatomy. The purpose of this paper is to describe that species.

## MATERIALS AND METHODS

Material was collected during the cruise of the R/V Dalnie Zelentsy in summer-autumn of 2014. Two specimens of the holothurian *Myriotrochus rinkii Steenstrup, 1851* infected with *Entocolax* were extracted from a bottom trawl and fixed with 4% formaldehyde. A single specimen from another locality was fixed with 96% ethanol.

The external morphology and internal anatomy of all three specimens were studied under a Motic K400 stereomicroscope with drawing tube. The scanning electron microscopy images of embryonic shells were taken with a CamScan S2.

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## SYSTEMATICS

Family **Eulimidae** Philippi, 1853

*Genus* ***Entocolax*** Voight, 1888

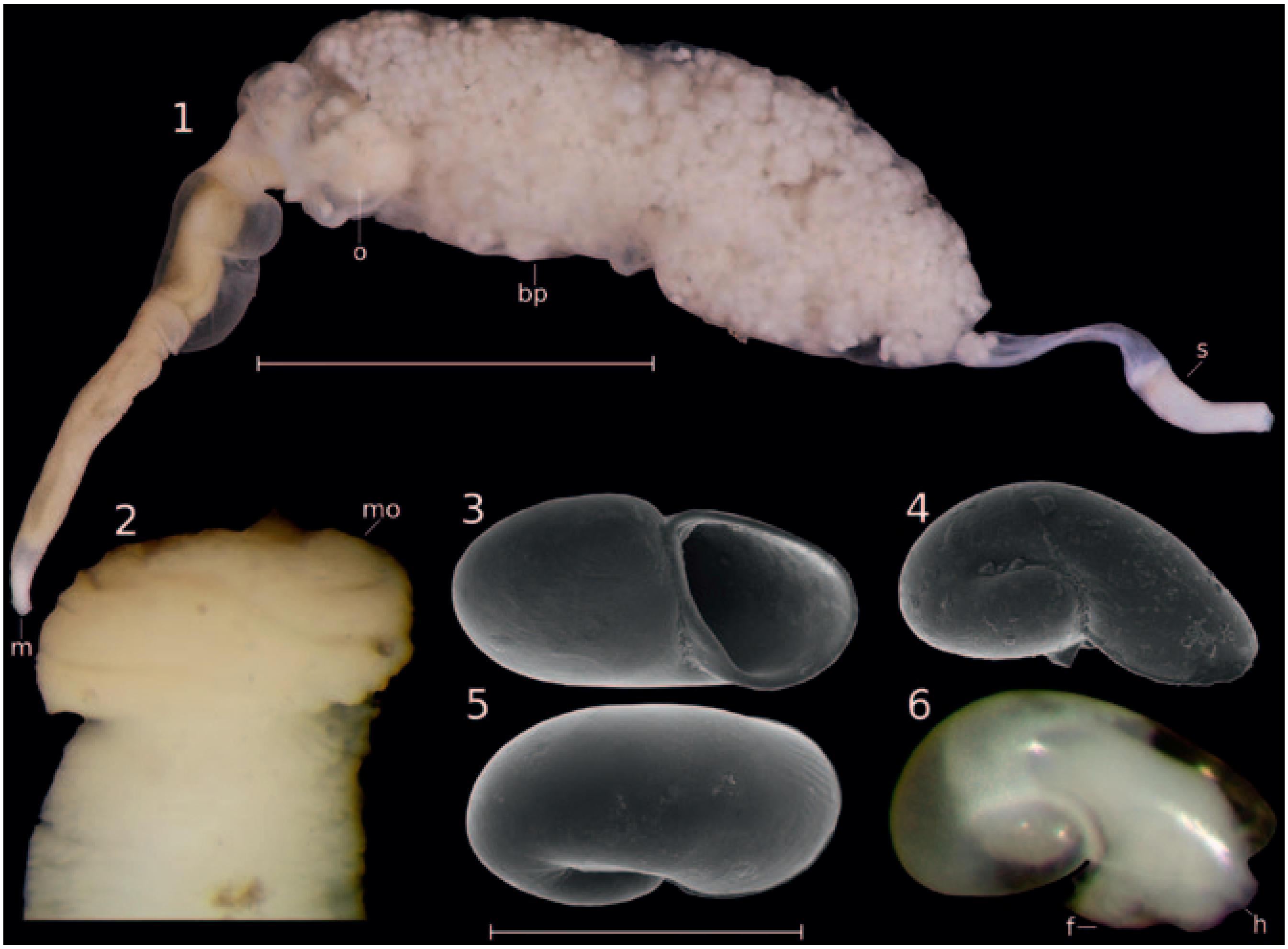
Type species *Entocolax ludwigi* Voigt, 1888 (by monotypy)

***Entocolax olgae*** sp. n.
(Figs 1–15)

*Type locality* Eastern Laptev Sea, 75°54.2'N, 134°29.3'E, depth 43m; brown silt, sand, clay, pebbles; observed temperature -1.72°C; salinity 33.8‰.

*Holotype* Single female from type locality, body length 37mm. 19 Aug. 2014, leg. O.L. Zimina. Stored in malacological collection of Zoological Institute of RAS (Saint-Petersburg, Russia), accession number 62017.

*Paratype* Single female from the same sample as holotype, partially damaged during collection and fixation, stored in the private collection of the author.



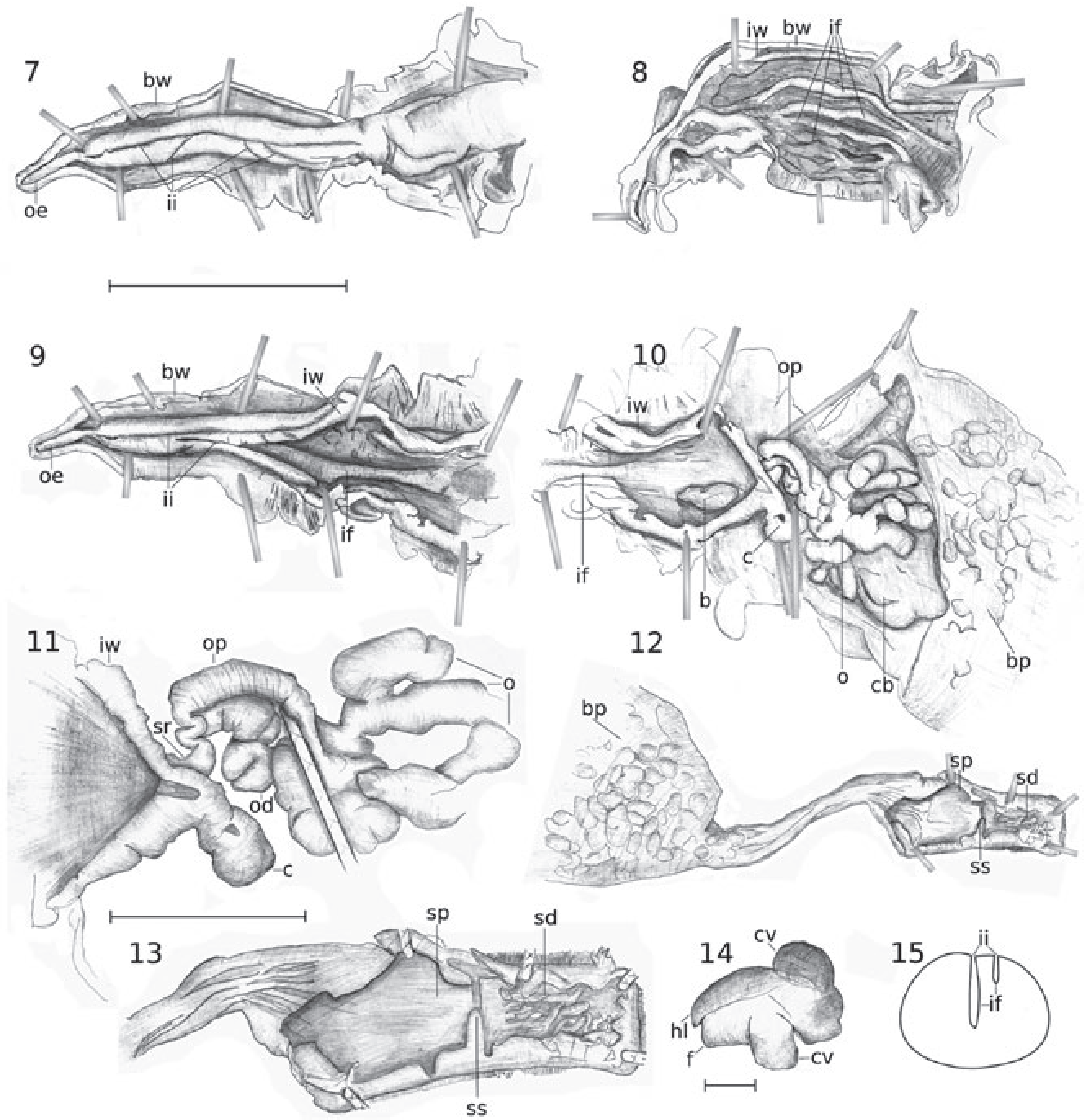

**Figures 1–6** External morphology of female and embryos of *Entocolax olgae*. **1** general view of the holotype of *Entocolax olgae*; **2** siphon with muscular organ, Laptev Sea, 75°11.9' N, 128°27.8' E; **3–6** embryos extracted from paratype. Abbreviations: **bp** brood-pouch; **f** foot; **h** head; **m** mouth; **mo** muscular organ; **o** ovary; **s** siphon. Scale bars: **1** 10mm; **2–6** 0.5mm.

*Additional material* Single female, eastern Laptev Sea, 75°11.9' N, 128°27.8' E, 36m; brown silt, sand, gray clay; temperature –1.5°C, salinity 33.7‰. 10 Sept. 2014, leg. O.L. Zimina. Tissue and extracted DNA are stored in the Atmosphere and Ocean Research Institute, The University of Tokyo with the accession number YK#2650.

*Description of Female. External morphology* Similar to other *Entocolax* species (Fig. 1). Adults shell-less, with long anterior part about one third of body length; mouth end acute. Central part of body significantly swollen, slightly less than half body length. Fixed specimens generally white, posterior end slightly darker than anterior, tissues of brood-pouch transparent.

*Internal anatomy* Oesophagus (Figs 7, 9, ***oe***), relatively short and thin. Relatively solid, blind intestine with deep external invaginations (Figs 7, 9, 15, ***ii***); all studied specimens had single longitudinal invagination originating directly behind oesophagus and terminating on proximal end of intestine, as well as a few shorter oblique or longitudinal folds. Invaginations form strong folds inside intestine (Figs 8, 9, 10, 15, ***if***). No radial folds discernible, and no gland tissues detected macroscopically; no lobes present in proximal part except single caecum (Figs 10–11, ***c***). Compact bolus observed (Fig. 10, ***b***) in proximal part of intestine of single specimen (holotype); no structured tissue remains detected in bolus under optical microscope.

Reproductive system consists of oviduct, ovary and brood-pouch. Oviduct lies behind posterior end of intestine; morphologically divided into proximal thin-walled (Figs 10, 11, ***op***) and




**Figures 7–15** Morphology of *Entocolax olgae.* **7** anterior part of the holotype, body wall dissected; **8** anterior part of the specimen from Laptev Sea, 75°11.9' N, 128°27.8', body wall and intestine dissected; **9–10** anterior part of the holotype, body wall and intestine dissected; **11** posterior part of the intestine (dissected) and reproductive system of the holotype; **12–13** posterior part of the holotype, siphon dissected, muscular organ probably lost; **14** general view of the male larvae; **15** schematic view of a cross section of the central part of the intestine. Abbreviations: **b** bolus; **bp** brood-pouch; **bw** body wall; **c** caecum; **cb** compact body; **cv** cavity; **f** foot; **if** intestine fold; **ii** intestine invagination; **iw** intestine wall; **hl** head lobe; **o** ovary; **od** distal part of oviduct; **oe** oesophagus; **op** proximal part of oviduct; **sd** distal part of siphon; **sp** proximal part of siphon; **sr** presumed seminal receptacle; **ss** siphonal septum. Scale bars: **7–10** & **12**–5mm; **11** & **13**–2mm; **14**–0.5mm; **15** – not scaled.

distal sinuous thick-walled (Fig. 11, ***od***) parts. Elongated sinuous caecum extends from oviduct to intestine and adheres to its side; probably corresponds to location of seminal receptacle (Fig. 11, ***sr***) in other species. Ovary (Figs 10, 11, ***o***) with numerous blind relatively thick branches, some accreted into fairly compact body (Fig. 10, ***cb***). Brood-pouch (Figs 1, 10, 12, ***bp***) thick-walled, with about 150–200 egg capsules; 4 to 21 eggs per capsule observed.

Siphon cylindrical, thick-walled; internally divided by septum (Fig. 12, 13, ***ss***) into proximal part with smooth walls (Figs 12, 13, ***sp***), and distal part with wrinkled wall surface (Fig. 12, 13, ***sd***). Posterior spherical muscular organ embedded in body wall of host (Fig. 2, ***mo***); not observed in holotype probably because of damage during extraction. Nervous system and sense organs not detected.

*Description of Male* Single male larva, 425×325µm (Fig. 14), found in proximal part of female's siphon (holotype). External morphology corresponds to early development stage described by Schwanwitsch (1917). Rudimentary foot (Fig. 14, f) and head lobe (Fig. 14, hl) developed; two extensive cavities (Fig. 14, cv), one corresponds to "posterior gland" of Schwanwitsch; shell absent. Internal anatomy not studied.

*Description of Larvae* Both holotype and paratype had developed larvae bearing orthostrophically coiled, white, glossy, semitransparent shells (Figs 3–6), some with irregular sculpture of rounded spiral ribs. Shell incompletely covers body. Foot (Fig. 6, f), head (Fig. 6, h) and thin transparent operculum present; no radula detected.

Mean values of morphometric characters of 34 larval shells: shell width 659µm (standard deviation 40, range 572–715µm); shell height 347µm (standard deviation 29, range 273–429µm); nucleus width 190µm (standard deviation 13, range 156–221µm).

*Parasitized host* *Myriotrochus rinkii* (Steenstrup, 1851).

*Geographic range* Known only from the material studied from the Laptev Sea.

*Derivation of name* The species is named after Mrs Olga Zimina who collected the specimens used for the description.

*Comparisons* *Entocolax olgae* is the only known species of the genus with longitudinal folds in the intestine. The position of the presumed spermal receptacle and structure of the siphon are also unique within all known representatives of the genus (see Table 1 for comparison).

## Discussion

Currently, there are seven described species of *Entocolax*: *E. ludwigii* Voigt, 1888, *E. schwanwitschi* Heding in Heding and Mandahl-Barth, 1938, *E. chiridotae* Scarlato, 1951, *E. rimskykorsakovi* A. Ivanov, 1945, *E. olgae* sp. n., *E. schiemenzi* Voigt, 1901 and *E. trochodotae* Heding, 1934. The latter two species live in the Southern Hemisphere. In addition, two females probably belonging to an undescribed species of *Entocolax* were reported from *Myriotrochos vitreus* (M. Sars, 1866) in Korsfjorden, Norway (Bouchet & Warén, 1986).

There is some confusion over the identity of *E. schwanwitschi*, which was introduced for the species parasitizing *Myriotrpohus rinkii* from the Kola Inlet (Barents Sea) and erroneously identified by Schwanwitsch (1917) as *E. ludwigii.* Heding (Heding & Mandahl-Barth, 1938) wrongly interpreted the locality of Schwanwitsch's material as the Kara Sea and considered his own material from that region to be the same species as *E. ludwigii sensu* Schwanwitsch. *Entocolax schwanwitschi* was described from specimens parasitizing *M. eurycyclus* Heding, 1935, which is unknown from the Kola Inlet or adjacent parts of the Murman Coast (Anisimova, 2000; Pavlova & Zuev, 2010; Lyubina et al., 2014). The original description of *E. schwanwitschi* is meagre and partially based on the investigation by Schwanwitsch (1917). Unfortunately, there have been no reliable records of *Entocolax* species since the beginning of the 20th century from the Kola Inlet or the Kara Sea (Kantor & Sysoev, 2006; Nekhaev, 2014). Hence whether Schwanwitsch's and Heding's species are conspecific cannot be established with certainty, and I prefer to use the name *E. cf. schwanwitschi* for the material studied by Schwanwitsch to distinguish the two forms.

Table 1 compares morphological features from published data (Voigt, 1888; *Schwanwitsch, 1917; Heding & Mandahl-Barth, 1938;* Ivanov, 1945; 1953; Scarlato, 1951) of six *Entocolax* species (including *E. cf. schwanwitschi*) known from Eurasian seas. The main differences between the species are in the organization of the intestine and siphon. The intestines have differently developed folds. Digestive glands were detected only

**Table 1** Morphological characters of *Entocolax* species known from Eurasian waters.

| Siphon | Length mm | Intestine | Ovary | Siphon | Nervous system, sense organs | Host | Where attached | Known distribution |
|---|---|---|---|---|---|---|---|---|
| *Entocolax olgae* | 37 | Deep longitudinal folds, no radial folds; single caecum at posterior end | Loose, some branches coalesced into compact body | Two parts divided from each other by septum; with muscular organ | Not found | *Myriotrpchus rinkii* (Steenstrup, 1851) | Body wall | Eastern Laptev Sea |
| *Entocolax ludwigii* | 35 | Radial folds | Loose, with anastomosis between branches, occasionally compacted | Simple, separated by membrane from the brood-pouch, with muscular organ | Agglomeration of nervous cells, no developed ganglion | *Myriotrpchus rinkii* (Steenstrup, 1851) | Body wall | Bering Sea, Greenland |
| *Entocolax schwanwitschi* | 20 | Undifferentiated, no folds nor lobes reported | Loose, no connection between branches reported | No data on internal morphology, probably lacking muscular organ | Not found | *Myriotrpchus euriciclus* Heding, 1935 | Not reported with certainty, probably intestine wall | Kara Sea |
| *Entocolax* cf. *schwanwitschi* | 20 | Radial folds, no lobes | Usually loose, occasionally ingrown into pseudopallium wall, no connection between branches | Three parts, separated from brood-pouch by septum, no muscular organ | Single statocyst, developed ganglion | *Myriotrpchus rinkii* (Steenstrup, 1851) | Intestine wall | Barents Sea: Kola Inlet |
| *Entocolax chiridotae* | 95 | Smooth intestine walls, no lobes | ingrown into pseudopallium wall | three parts, all with transverse wrinkles, no septum, with constrictor muscle at the posterior end | Not found | *Chiridota pellucida* (Vahl, 1806) | Not observed | Sea of Japan: Laperouse Strait |
| *Entocolax rimskykorsakovi* | 14 | Strong radial folds, posterior end divided into lobes | Loose, no connection between branches reported | No subdivision, separated from brood-pouch by septum, no muscular organ | Single statocyst, possibly agglomeration of nervous cells, no developed ganglion | *Myriotrpchus mitsukurii* Ohshima, 1915 | Intestine wall | Sea of Japan: Peter the Great Bay |

in *E. rimskykorsakovi* and were located behind the proximal part of the oesophagus (Ivanov, 1945; 1953).

Siphons are usually divided macromorphologically into two or three parts and, in some cases, are divided from the brood-pouch by a septum. A muscular organ at the posterior end of the siphon, used to embed the parasite in the body wall of the host, is so far known in only two species, but, as noted in Heding & Mandahl-Barth (1938), its development depends on the age of the specimen.

There is significant infraspecific variation in the development of the ovary. Generally, it consists of a body with numerous branches that may coalesce. Ingrowing of the ovary into the pseudopallium wall was reported for two species. Statocysts were not found in three species. Males are unknown for *E. chiridotae,* and only one male larva was found in *E. olgae.* The number and sizes of embryos were not reported for all species. Egg capsules contain from single figures to a few tens of eggs. Reported numbers of capsules per female vary from 30 in *E. cf. schwanwitschi* to 150–200 in *E. olgae*. All known juveniles of *Entocolax* species are very similar in shell shape and size. The smallest reported embryonic shells (about 400µm) were in *E. schwanwitschi*, whereas juveniles of both *E. ludwigii* and *E. olgae* have shells about 600µm in diameter. Altnöder et al. (2007), on the coast of Chile, reported shelled juvenile gastropods on the exterior of the holothurian *Chiridota pasanii* Ludwig, 1886 and suggested they were larvae of *Entocolax schiemenzii*. But the specimens described by Altnöder et al. (2007) are significantly more rounded, less elongated and considerably smaller (reported shell diameter is not more than 308µm) than known juveniles of *Entocolax.*

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