Some remarks on the subgenus *Oligotrochus* M. Sars, 1866 *sensu* Heding, 1935 (genus *Myriotrochus*, Myriotrochidae, Holothurioidea) with description of two new species

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ABSTRACT
The composition and evolution of the subgenus *Oligotrochus* [genus *Myriotrochus* (Myriotrochidae, Apodida, Holothurioidea)] are discussed. In addition to the type species of the subgenus, *M.* (*O.*) *vitreus* (M. Sars, 1866), two other species are transferred to this subgenus: *M.* (*O.*) *clarki* Gage *et* Billett, 1986 and *M.* (*O.*) *bathybius* H. L. Clark, 1920. Moreover, two new species are described: *M.* (*O.*) *rotulus* n.sp. from the West Galicia coast, Spain, Northeast Atlantic and *M.* (*O.*) *neocaledonicus* n.sp. from the Loyalty Islands Basin, New Caledonia, Pacific. *M.* (*O.*) *rotulus* n.sp. is characterized by wheels with "fused spokes". The spokes in these wheels are swollen and sometimes are fused, leaving small oval holes near the hub. The number of these holes corresponds to the number of fused pairs of spokes and ranges from two up to the total number of spokes. These wheels usually have less hub perforations than spokes, because not all of the spokes are fused. The latter character and a smaller size of the wheels clearly differ *M. rotulus* from *M. bathybius* and *M. neocaledonicus*, which have wheels with hub penetrated by a complete circle of perforations. *M.* (*O.*) *neocaledonicus* n.sp. is characterized by wheels with perforated hub which closely resemble wheels of *M.* (*O.*) *bathybius*. The new species differs from *M.* (*O.*) *bathybius* in having a smaller length of hub perforations and by the shape of these perforations (triangular or ovoid-triangular in *M.* (*O.*) *neocaledonicus*, and ovoid in *M.* (*O.*) *bathybius*). An identification key for the species belonging to the subgenus *Oligotrochus* is given.

KEY WORDS
Holothurians,
Myriotrochidae,
new species,
Northeast Atlantic,
New Caledonia.

RÉSUMÉ

Remarques sur le sous-genre Oligotrochus *M. Sars, 1866* sensu *Heding, 1935 (genre* Myriotrochus*, Holothurioidea, Myriotrochidae) et description de deux nouvelles espèces.*

La composition et l'évolution du sous-genre *Myriotrochus* du genre *Oligotrochus* (Myriotrochidae, Apodida, Holothurioidea) sont discutées. En plus de *M.* (*O*). *vitreus* (M. Sars, 1866), l'espèce-type du sous-genre, deux autres espèces sont transférées dans ce sous-genre : *M.* (*O.*) *clarki* Gage *et* Billett, 1986 et *M.* (*O.*) *bathybius* H. L. Clark, 1920. De plus, deux espèces nouvelles sont décrites : *M.* (*O.*) *rotulus* n.sp. de la côte ouest de la Galice (Espagne, Atlantique Nord-Est) et *M.* (*O.*) *neocaledonicus* n.sp. du bassin des îles Loyauté (Nouvelle-Calédonie, Pacifique). *M.* (*O.*) *rotulus* n.sp. est caractérisée par des roues avec des "rayons fusionnés". Les rayons dans ces roues sont élargis dans la partie médiane, et fusionnent parfois, laissant de petits trous ovoïdes près du moyeu. Le nombre de ces trous correspond au nombre de couples de rayons fusionnés et varie de deux jusqu'au nombre complet des rayons. Ces roues possèdent habituellement moins de trous que de rayons, les rayons n'étant pas tous fusionnés. Par ce dernier caractère et par la plus petite dimension des roues, *M.* (*O.*) *rotulus* diffère donc de *M.* (*O.*) *bathybius* et de *M.* (*O.*) *neocaledonicus* qui se caractérisent par des roues avec un cercle complet de trous dans le moyeu. *M.* (*O.*) *neocaledonicus* n.sp. est très proche de *M.* (*O.*) *bathybius*, seules la dimension et la configuration de leurs trous restent différentes : chez *M.* (*O.*) *neocalidonicus*, ils sont plus petits et triangulaires, chez *M.* (*O.*) *bathybius*, ils sont ovoïdes ou ovoïdes-triangulaires. Une clé des espèces du sous-genre *Oligotrochus* est proposée.

MOTS CLÉS
Holothuries,
Myriotrochidae,
espèces nouvelles,
Atlantique Nord-Est,
Nouvelle-Calédonie.

INTRODUCTION

The genus *Oligotrochus* was established by M. Sars (1866) for his new species *Oligotrochus vitreus* M. Sars, 1866. A detailed description of the new genus and species were published some years later (M. Sars 1877). In the latter paper M. Sars indicated the following characters to distinguish his new genus from the genus *Myriotrochus* Steenstrup, 1851: (1) "only a very small number of microscopic calcareous wheels being found in the anterior and posterior part of the skin of the body and none elsewhere"; (2) "calcareous wheels lie sunk in the skin of the body, while in the *Myriotrochus* they project above its surface supported on skin-stalks"; (3) "the wheels have usually a smaller number of rays [*i.e.* spokes]"; (4) "the tentacle [in *Oligotrochus*] [...] being more like those of the *Synapta*, round, conically pointed and in their outer part furnished with finger-like branches on both sides of the stem [...] while in the *Myriotrochus* they seem as in the *Chirodota* to be disk-like or hand-shaped at the extremity (tentacula peltato-digitata) their outer half being broader and flattened on the outside, and having finger-like branches on the margin" (M. Sars 1877: 56-57).

Later *Oligotrochus vitreus* was synonymized with *Myriotrochus brevis* (Huxley, 1852) by Danielssen & Koren (1879). The latter name also was synonymized with *Myriotrochus rinkii* Steenstrup, 1851 by Lütken (1857). Correspondingly the genus *Oligotrochus* was regarded as a synonym of the genus *Myriotrochus*.

Östergren (1898) in his famous paper dealing with the system of the apodid holothurians placed two species, *M. rinkii* and *M. vitreus*, in the genus *Myriotrochus*. Later, Östergren (1903) gave a detailed description of *Myriotrochus vitreus* which era-

sed all doubts on the validity of this species. At the same time, he believed that the differences between *M. rinkii* and *M. vitreus* are not strong enough to place these species into two different genera and considered *Oligotrochus* a junior synonym of *Myriotrochus*. Östergren's opinion was accepted by H. L. Clark (1907) in his monograph on apodid holothurians, and by following authors of local faunas (Mortensen 1924; Koehler 1927).

In 1935, Sven Heding studied some new material of *M. vitreus*. Following Östergren (1898, 1903) he believed that differences in wheel characters and in wheels disposition in the body wall are not important enough to place *M. vitreus* and *M. rinkii* into two separate genera. However, he stressed the peculiarity of the tentacle structure of *M. vitreus* (Heding 1935: 23): "The tentacles are very conspicuous, being rather stiff, and 'pinnate' having the digits placed on the sides. The shape of the tentacles is thus very different from that of the tentacles of *M. rinkii*." He proposed to keep *M. vitreus* in the genus *Myriotrochus*, but to place this species in a separate subgenus *Oligotrochus*. In the most recent papers dealing with the family Myriotrochidae (Belyaev & Mironov 1982; Gage & Billett 1986) Heding's suggestion was not cited or commented on, although Belyaev & Mironov (1982) presented new data on the morphology of the calcareous ring of *M. vitreus*, and Gage & Billett (1986) described a new species *M. clarki* which is very close to *M. vitreus*.

Diagnoses of the genus *Myriotrochus* and subgenus *Oligotrochus*, description of two new species, *Myriotrochus* (*Oligotrochus*) *rotulus* and *M.* (*O.*) *neocaledonicus*, and some notes on other species placed in *Oligotrochus* are given below.

METHODS

Following Belyaev (1970), Belyaev & Mironov (1982) and Gage & Billett (1986) for description of the wheel ossicles from the body wall I use the following parameters: D, wheel diameter (µm); S, number of spokes; T, number of teeth; S/T, proportion of spokes to teeth (%); Lt, tooth length (µm); and the ratio Lt/D (%).

The hub centre is sometimes surrounded by a circle of small oval or triangular perforations which correspond in number to that of the spokes (Figs 3, 4). This feature makes it possible to use some additional characters for wheels description: Dhp, the diameter of the primary hub or internal hub diameter, *i.e.* diameter of the circle inside the circle of the hub perforations (µm); the ratio Dhp/D (%); Dhs, the secondary hub diameter, *i.e.* the diameter of the large hub itself; the ratio Dhs/D; Lo, the length of the hub perforations (µm); and the ratio Lo/D (%).

SYSTEMATICS

Genus *Myriotrochus* Steenstrup, 1851

Myriotrochus Steenstrup, 1851: 60. – Lütken 1857: 21. – Semper 1868: 8. – Théel 1877: 2; 1886: 37. – Lampert 1885: 23. – Ludwig 1889-1892: 360. – H. L. Clark 1907: 127. – Heding 1935: 19. – Tortonese 1938: 205. – Belyaev & Mironov 1982: 94, fig. 15.

DIAGNOSIS

Myriotrochidae with twelve tentacles. Calcareous ring consists of ten pieces. Two dorsolateral pieces are double, i.e. possess two anterior processes and additional frontal excavations for tentacular ampullae of two extra tentacles. Other pieces have one anterior process each. Radials are perforated for the passage of the radial nerves. Intestine has a loop. Gonads are paired. Body wall ossicles wheels with a flat hub, nine to twenty-five spokes and large teeth on the inner part of the rim; the teeth are directed towards the centre of the wheel (myriotrochid type).

Subgenus *Oligotrochus* M. Sars, 1866

Oligotrochus M. Sars, 1866: 200 (*pro genus*); 1877: 57 (*pro genus*). – G. Sars 1872: 29 (*pro genus*). – Heding 1935: 21.

TYPE SPECIES. — *Oligotrochus vitreus* M. Sars, 1866, by original designation.

SPECIES INCLUDED. — Subgenus includes five species: *Oligotrochus vitreus* M. Sars, 1866; *Myriotrochus bathybius* H. L. Clark, 1920; *M. clarki* Gage *et* Billett, 1986; *M. neocaledonicus* n.sp., and *M. rotulus* n.sp.

DIAGNOSIS

Myriotrochus with large conical tentacles with two to five pairs of small lateral digits or (?) without digits. There are no ossicles in the tentacles. Calcareous ring massive, stout, with undulating posterior edge. Body wall ossicles wheels of myriotrochid type with whole hub and/or with hub perforated by a circle of holes.

DISCUSSION

The subgenus *Oligotrochus* is characterized by having conical tentacles which have small finger-like lateral digits whereas the subgenus *Myriotrochus* is characterized by palm-like "peltato-digitate" tentacles. This difference is clearly seen in Figure 1, comparing Heding's figures of the tentacles of *M.* (*Myriotrochus*) *rinkii* (type species of the nominotypical subgenus *Myriotrochus*) and *M.* (*Oligotrochus*) *vitreus* (type species of the subgenus *Oligotrochus*). The drawings and description of the tentacles of other species of the subgenus *Oligotrochus* can be easily found elsewhere: *M.* (*O.*) *vitreus* in M. Sars (1877: 51, table 7, figs 4, 5) and Östergren (1938, tafl. 1, fig. 8); *M.* (*O.*) *clarki* in Gage & Billett (1986: 250, figs 17A, B); *M.* (*O.*) *bathybius* in H. L. Clark (1920: 126); *M.* (*O.*) *bathybius* from Northeast Atlantic in Gage & Billett (1986: 234-235, figs 3E, F); *M.* (*O.*) *neocaledonicus* (Fig. 2).

Myriotrochus (*Oligotrochus*) *vitreus* (M. Sars, 1866)

Oligotrochus vitreus M. Sars, 1866: 200; 1877: 49, table 7, figs 1-17. – G. Sars 1872: 30. – Danielssen & Koren 1879: 111. – Storm 1879: 22.
Myriotrochus vitreus – Östergren 1898: 119; 1903: 18; 1938: tafl. 1, fig. 8, tafl. 2, fig. 12. – Clark 1907: 128, pl. 8, figs 15-20. – Grieg 1912: 12; 1914: 140; 1928: 11. – Mortensen 1924: 256, fig. 128; 1927: 438, fig. 269. – Koehler 1927: 285. – Mortensen & Lieberkind 1928: 32, fig. 64. – Heding 1931: 695. – Djakonov 1933: 159. – Belyaev & Mironov 1982: 97, figs 9, 17. – Høisæter 1990: 100. – Madsen & Hansen 1994: 122, figs 64G, 82-3, 84, 85, map 34.
Myriotrochus (*Oligotrochus*) *vitreus* – Heding 1935: 23, figs 3-7, pl. 1, figs 1-3, pl. 2, figs 5-8, 13-22, 26-28, pl. 3, figs 1, 2.
Myriotrochus brevis – Danielssen & Koren 1882: 31, table 5, figs 5-7.
Non *Myriotrochus vitreus* – Verrill 1874: 413 = *Myriotrochus rinkii* Steenstrup, 1851.
Non *Myriotrochus vitreus* – Cherbonnier 1970: 1269 = *Myriotrochus clarki* Gage *et* Billett, 1986.
Non *Myriotrochus vitreus meridionalis* – Salvini-Plawen 1977: 76 = *Prototrochus meridionalis* (Salvini-Plawen, 1977).

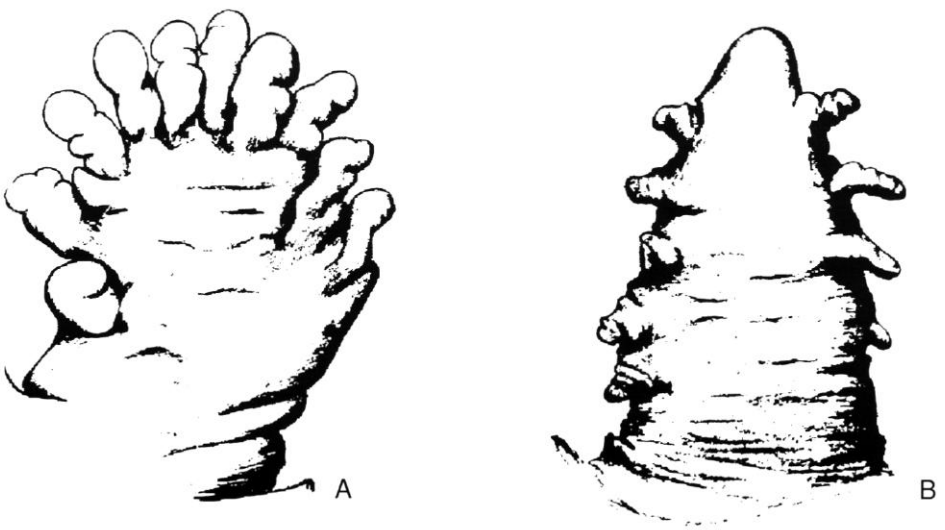

FIG. 1 — Tentacle; **A**, *Myriotrochus* (*Myriotrochus*) *rinkii* Steenstrup, 1851; **B**, *Myriotrochus* (*Oligotrochus*) *vitreus* (M. Sars, 1866). Redrawn from Heding (1935).

REMARKS

The anatomy and morphology of this species are well described in several papers (M. Sars 1877; Östergren 1903; Heding 1935; Belyaev & Mironov 1982). The species is distributed near Scandinavia from Skagerak to Lofoten and has also been mentioned near the Faroe Islands. It lives at the depth of 90-700 m on muddy bottom (Madsen & Hansen 1994). The record near the Faroe Islands (Madsen & Hansen 1994: map 34) requires confirmation as this location is much further from the well-known distribution area of this species than from where the closely related species *M. clarki* has been found.

Myriotrochus (*Oligotrochus*) *clarki*
Gage *et* Billett, 1986

Myriotrochus clarki Gage *et* Billett, 1986: 247, figs 1, 7D, 9D, 13-17, 18A.
Myriotrochus vitreus – Cherbonnier 1970: 1269.

MATERIAL EXAMINED. — **Northeast Atlantic.** RV *Thalassa*, stn 825, 42°22'4N, 9°28'2W, depth 480-520 m, muddy sand with clay and pebbles, 21.X.1968, 1 specimen deposited in the Muséum national d'Histoire naturelle (MNHN), Paris, No. EcHh 2511.

REMARKS

This species is very similar to *M. vitreus* and it was described from the Rockall Trough at depths between 1605 and 2515 m only recently. The specimen described by Cherbonnier as *Myriotrochus vitreus* is 15 mm long and 3.5 mm in diameter without ossicles in the body wall. The stout calcareous ring, which has high ventral and lateral pieces (the ventral pieces are twice as long as the dorsal ones), is very similar to the calcareous ring of *M. vitreus* and *M. clarki*. Twelve conical tentacles have one or two pairs of small lateral digits. These characters enable this specimen to be identified as *M. clarki*, which also has two pairs of small lateral digits on each tentacle, contrary to *M. vitreus* which has four to five pairs.

Myriotrochus (*Oligotrochus*) *bathybius*
H. L. Clark, 1920

Myriotrochus bathybius H. L. Clark, 1920: 126, pl. 4, fig. 3. – Carney & Carey 1976: 69. – Gage & Billett 1986: 234, figs 1, 3-6, 7A, B, 9A, B, 18B.

REMARKS

This species was described from the eastern tropical Pacific, 4°33'S, 87°42'30"W, from the depth of 3665 m (H. L. Clark 1920), and later was mentioned without description by Carney & Carey (1976) from the Oregon coast at a depth of 4000 m. Gage & Billett (1986) described specimens from the Rockall Trough, and Porcupine Seabight, in the Northeast Atlantic (1800-4310 m) with wheels that have the hub perforated by a circle of holes, as *M. bathybius*. They also cited the unpublished data of the late Dr Bent Hansen concerning myriotrochid specimens from the South Atlantic and Indian Oceans identified as *M. bathybius*.
The wheels of the Northeast Atlantic specimens described by Gage & Billett (1986) differ somewhat from the wheels of the holotype of *M. bathybius* (Figs 4B, C), and there are therefore some doubts as to the identification of the Northeast Atlantic specimens as *M. bathybius*.
Unfortunately, the holotype of *M. bathybius* stored in the Museum of Natural History,

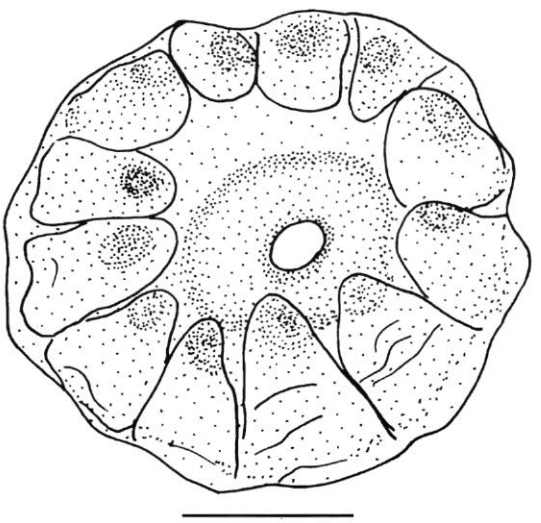

FIG. 2. — *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp.; anterior part, view from above. Scale bar: 1 mm.

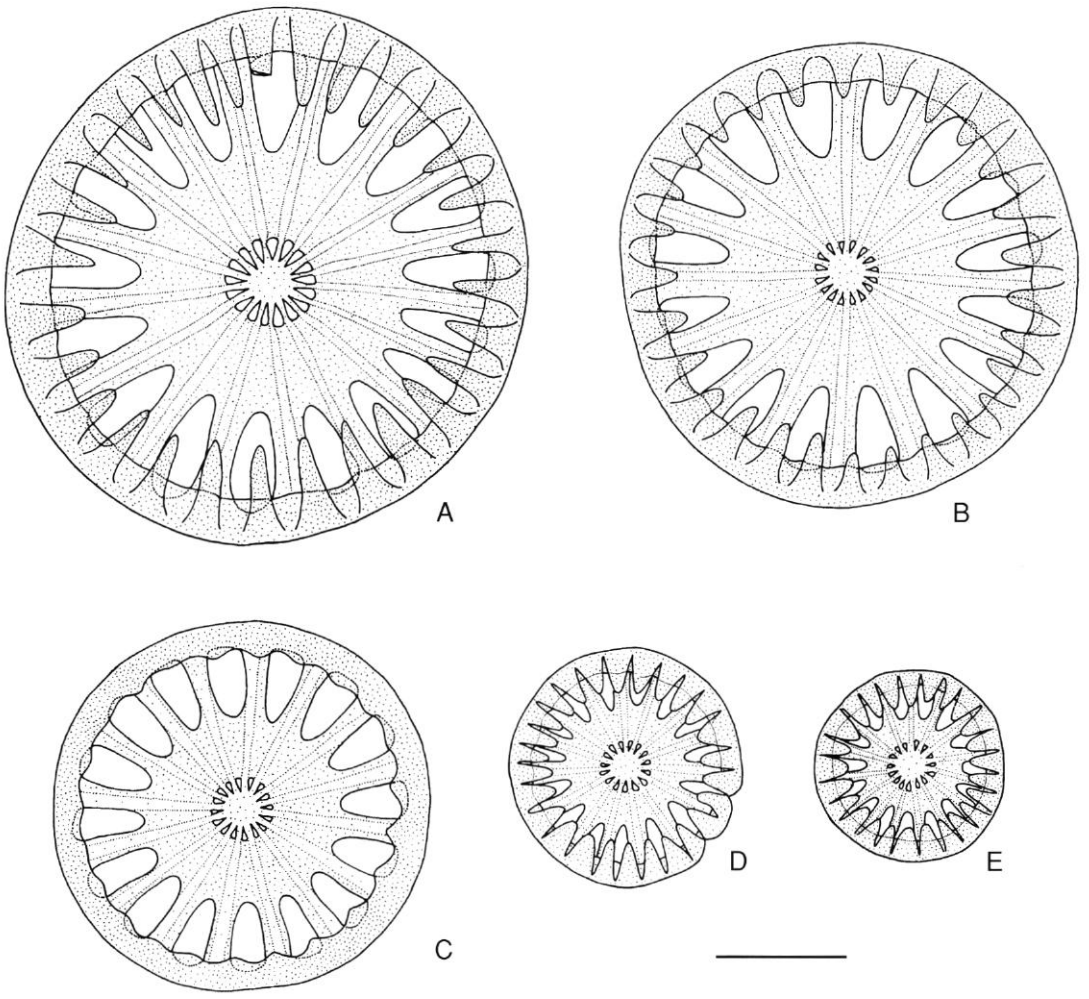

FIG. 3. — *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp.; **A**-**B**, large wheels from the body wall; **C**, wheel with reduced teeth; **D**-**E**, small wheels from the anterior portion of the body. Scale bar: 100 µm.

Smithsonian Institution, Washington D.C. is almost lacking wheels and the microscopical slide with wheels described by H. L. Clark (1920) is untraceable. Thus, it is necessary to find new material from the type locality of *M. bathybius* for redescription. Only then will it be possible to justify the determination of the Northeast Atlantic material as *M. bathybius*.

Myriotrochus neocaledonicus n.sp.

MATERIAL EXAMINED. — **New Caledonia.** Loyalty Islands Basin, expedition Biogeocal, RV *Coriolis*, stn CP232, 21°33'81-21°34'04 S, 166°19'84-166°27'18 E, 760-790 m depth, beam trawl, 12.IV.1987, holotype stored in the MNHN, No. EcHh 8007.

ETYMOLOGY. — The species is named after the New Caledonian region.

DESCRIPTION

The fragment of the anterior portion of the body with the calcareous ring is 3 mm in diameter and 1.2 mm long; the shapeless body fragment is

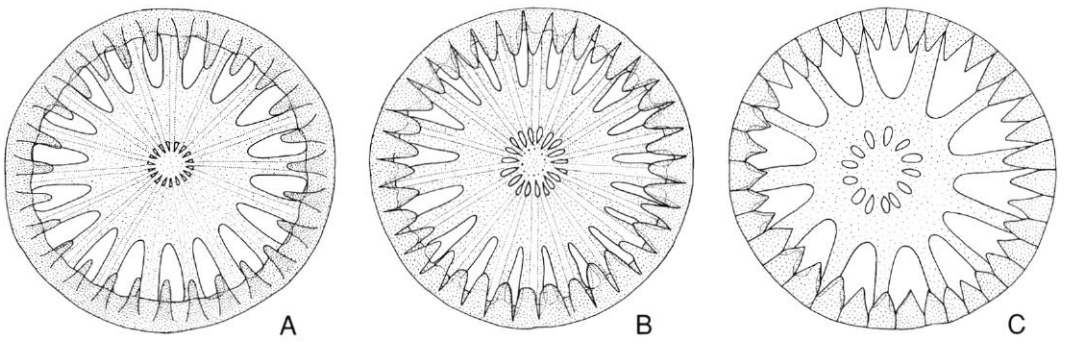

FIG. 4. — Comparison of the wheels of *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp. and *M.* (*O.*) *bathybius* H. L. Clark, 1920; **A**, *M. (O.) neocaledonicus* n.sp. (holotype); **B**, *M.* (*O.*) *bathybius* from Northeast Atlantic (SMBA, stn ES27); **C**, *M.* (*O.*) *bathybius* from Pacific, holotype (redrawn from H. L. Clark 1920, pl. 4, fig. 3). Scaled to the same size.

TABLE 1. — Parameters of the common wheels of *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp. See "Methods" for abbreviations.

Parameter	D (µm)	S	T	S/T (%)	Dhp (µm)	Dhp/D (%)	Dhs (µm)	Dhs/D (%)	Lo (µm)	Lo/D (%)	Lt (µm)	Lt/D (%)
	300	16			25	8.3	145	48.3	13	4.3		
	330	17	27	63.0	25	7.6	160	48.5	11	3.3	65	19.7
	350	15	26	57.7	20	5.7	170	48.6	11	3.1	70	20.0
	360	16	28	57.1	28	7.8	180	50	12	3.3	63	17.5
	365	16	26	61.5	28	7.7	185	50.7	13	3.6	75	20.5
	395	18	27	66.7	30	7.6	185	46.8	15	3.8	65	16.5
	410	17	28	60.7	35	8.5	205	50	15	3.7	80	19.5
	410	17	29	58.6	30	7.3	205	50	20	4.9	80	19.5
	450	16	29	55.2	33	7.3	235	52.2	20	4.4	90	20.0
n	9	9	8	8	9	9	9	9	9	9	8	8
mean	374.4	16.4	27.5	60.06	28.2	7.54	185.6	49.46	14.4	3.83	73.5	19.2
σ	46.2	0.9	1.2	3.68	4.5	0.80	26.9	1.58	3.5	0.59	9.5	1.4

TABLE 2. — Parameters of the small wheels of *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp. See "Methods" for abbreviations.

Parameter	D (µm)	S	T	S/T (%)	Dhp (µm)	Dhp/D (%)	Dhs (µm)	Dhs/D (%)	Lo (µm)	Lo/D (%)	Lt (µm)	Lt/D (%)
	120	14	25	56.0								
	155	15	25	60.0	18	11.6	80	51.6	10	6.5		
	160	15	25	60.0	20	12.5	73	45.6	10	6.3	32	20
	185	15	26	57.7	20	10.8	95	51.4	11	6.0	37	20
n	4	4	4	4	3	3	3	3	3	3	2	2
mean	155.0	14.8	25.3	58.42	19.3	11.63	82.7	49.53	10.3	6.22	34.5	20
σ	26.77	0.50	0.50	1.948	1.15	0.850	11.24	3.408	0.58	0.25	3.54	0

5 mm long. The skin is semitransparent; the colour in alcohol is whitish.

There are twelve conical tentacles. I could not find the lateral digits but this may be caused by contraction of the specimen and/or poor conservation. Tentacles are attached to the frontal side

TABLE 3. — Wheels parameters of *Myriotrochus* (*Oligotrochus*) *neocaledonicus* n.sp., *M.* (*O.*) *bathybius* from Central Pacific (after H. L. Clark 1920, pl. 4, fig. 3), *M.* (*O.*) *bathybius* from SMBA, stn ES27, Northeast Atlantic and *M.* (*O.*) *bathybius* from Northeast Atlantic (data on all Northeast Atlantic SMBA specimens which had been investigated by Gage & Billett 1986). See "Methods" for abbreviations.

Character	*M.* (*O.*) *neo-caledonicus*	*M.* (*O.*) *bathybius*, Pacific	*M.* (*O.*) *bathybius*, stn ES27	*M.* (*O.*) *bathybius*, Atlantic	Character	*M.* (*O.*) *neo-caledonicus*	*M.* (*O.*) *bathybius*, Pacific	*M.* (*O.*) *bathybius*, stn ES27	*M.* (*O.*) *bathybius*, Atlantic
D (µm)					Dhs (µm)				
mean	306.9	300	326.7	312.1	mean	159.8	130	157.5	–
n	13	1	6	339	n	12	1	6	
σ	112.8		40.3		σ	52.1		19.0	
min.	120		275	209	min.	73		130	
max.	450		380	398	max.	235		185	
S					Dhs/D (%)				
mean	15.9	13.0	17.0	15.5	mean	49.5	43.34	8.3	–
n	13	1	6	108	n	12	1	6	
σ	1.1		2.6		σ	2.0		2.0	
min.	14		13	10	min.	45.6		45.7	
max.	18		20	23	max.	52.2		51.6	
T					Lo (µm)				
mean	26.8	38.0	35.0	31.5	mean	13.4	17.0	21.3	–
n	12	1	6	106	n	12	1	6	
σ	1.5		2.5		σ	3.5		2.3	
min.	25		32	26	min.	10		18	
max.	29		38	40	max.	20		25	
S/T (%)					Lo/D (%)				
mean	59.5	34.2	48.7	50.3	mean	4.4	6.7	6.5	–
n	12	1	6	106	n	12	1	6	
σ	3.2		8.1		σ	1.2		0.3	
min.	55.2		40.6	34	min.	3.1		6.2	
max.	66.7		62.5	82	max.	6.5		7.0	
Dhp (µm)					Lt (µm)				
mean	26.0	40	28.5	–	mean	65.7	38	48.5	
n	12	1	6		n	10	1	6	
σ	5.6		4.8		σ	18.5		6.5	
min.	18		22		min.	32		38	
max.	35		35		max.	90		55	
Dhp/D (%)					Lt/D (%)				
mean	8.6	13.3	8.7	–	mean	19.1	12.7	14.8	–
n	12	1	6		n	10	1	6	
σ	2.0		0.8		s	1.7		0.8	
min.	5.7		7.6		min.	15.2		13.8	
max.	12.5		9.5		max.	20.5		19.6	

of the calcareous ring and are directed towards the oral orifice (Fig. 2).

Calcareous ring consists of ten pieces. The height of the pieces decreases slightly from ventral to dorsal side. The posterior surface of the pieces is concave, thus the lower contour of the ring is undulating. The anterior processes are relatively short.

TABLE 4. — Parameters of the wheels of myriotrochid type of *Myriotrochus* (*Oligotrochus*) *rotulus* n.sp. See "Methods" for abbreviations.

Parameter	D (µm)	S	T	S/T (%)	Dhp (µm)	Dhp/D (%)	Lt (µm)	Lt/D (%)
	70	11	19	57.9	13	18.6	16	22.8
	70	12	19	63.2	12	17.1	17	24.3
	75	12	20	60.0	14	18.7	17	22.7
	78	13	21	61.9	18	23.1	17	21.8
	80	12	22	54.6	18	22.5	18	22.5
n	5	5	5	5	5	5	5	5
mean	73.3	12.0	19.8	59.5	15.0	19.99	17.0	22.82
σ	4.6	0.7	1.3	3.41	2.8	2.63	0.7	0.91

Unfortunately, owing to the poor condition of the material it is impossible to describe the internal anatomy of the species.

Calcareous ossicles of the body wall are represented only by wheels with perforated hub. The large hub has small perforations of triangular or oval-triangular shape forming a regular circle (Fig. 3). Number of perforations corresponds to the number of spokes. Wheels in the body wall have a large size ranging from 300 to 450 µm. Wheel parameters are given in Table 1.

In the very anterior portion of the body, close to the calcareous ring, there are wheels of the same structure as just described, but of much smaller size 120-185 µm in diameter (Fig. 3D, E). Parameters of these small wheels are given in Table 2.

Comparison between the wheels of *M. neocaledonicus* and *M. bathybius* are given in Table 3. Wheel teeth vary in size and are almost lacking in one wheel (Fig. 3C).

There are no calcareous ossicles in the tentacles.

DISCUSSION

The single myriotrochid species characterized by the wheels with hub perforated by a circle of holes is *M. bathybius* H. L. Clark, 1920.

Because of the lack of information of the calcareous ossicles on the holotype of *M. bathybius* the only way to compare *M. neocaledonicus* with *M. bathybius* is to use Clark's description and drawing (Clark 1920: 126, 127, pl. 4, fig. 3). During my visit to the London Natural History Museum in 1985 I studied the wheels ossicles of Gage & Billett's specimens from the Northeast Atlantic (SMBA, stn ES27, 54°40'N, 12°16'W, 2880 m). This gave me the opportunity to compare the new species with the Northeast Atlantic specimens, not only by means of traditional characters, but also using such parameters as the internal hub diameter and the length of the hub hole.

The wheels of Northeast Atlantic specimens described by Gage & Billett (1986) differ somewhat from the wheels of the holotype of *M. bathybius*. Thus, I compare *M. neocaledonicus* with the holotype of *M. bathybius*, and with the Northeast Atlantic specimens identified by Gage & Billett (1986) as *M. bathybius* separately (Table 3).

The new species clearly differs from the holotype of *M. bathybius* and from the Northeast Atlantic specimens in having a smaller length of hub perforations (Table 3). The average length of perforations in *M. neocaledonicus* is 13.4 ± 1.0 µm, the perforation length of the holotype of *M. bathybius* measured from the drawing of H. L. Clark (1920) is 17 µm and the average perforation length of the Northeast Atlantic specimen is 21.3 ± 1.0 µm. Correspondingly, the average Lo/D ratios are 4.4 ± 0.4%, 6.7% and 6.5 ± 0.1%. The shape of these perforations are triangular or ovoid-triangular in *M. neocaledonicus*, and ovoid in the holotype of *M. bathybius* and the Northeast Atlantic specimens of *M. bathybius* (Fig. 4).

Unfortunately, the small number of wheels in the specimens at hand did not allow to use traditional statistical methods for comparing the wheel's parameters. The new species differs in having a

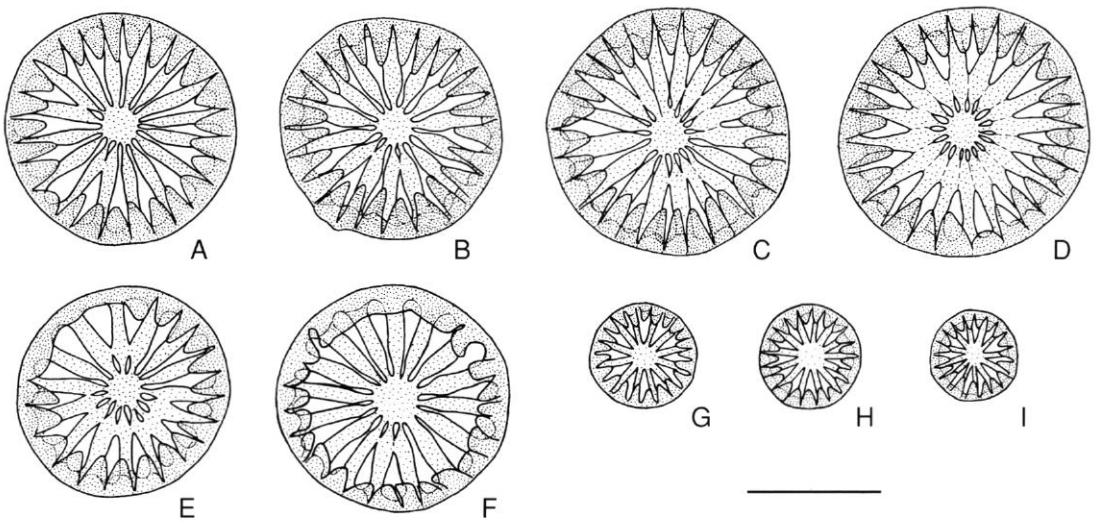

FIG. 5. — *Myriotrochus rotulus* n.sp.; **A-F**, wheels with fused spokes; **E-F**, wheels with some teeth merged with each other; **G-I**, wheels of myriotrochid type. Scale bar: 100 µm.

smaller number of teeth (Table 3) and hence by a larger S/T ratio. Besides, *M. bathybius* seems to live deeper than *M. neocaledonicus*. Up to now, the new species has been collected from 760-790 m depth, whereas *M. bathybius* was collected in the Pacific from 3665-4000 m depth, and in the Northeast Atlantic from 1800-4310 m depth.

Myriotrochus rotulus n.sp.

Myriotrochus sp. – Cherbonnier 1969: 359-360, figs 6A-C.

MATERIAL EXAMINED. — **Northeast Atlantic.** Spain, West Galician coast, RV *Thalassa*, stn 485, 43°47'2N, 8°48'1W, depth 485 m, muddy sand with abundant globigerinas, 8.VIII.1967, holotype stored in the MNHN, No. EcHh 3420.

ETYMOLOGY. — From the Latin *rotula*, "small wheel".

DESCRIPTION

The holotype is a fragment of the body wall, 30 mm long. Skin is semitransparent; the colour in alcohol is whitish. Wheels are not very numerous and were found in only one part of the fragment. They lie in the skin separately, not overlapping. Wheels are not located in the papillae contrary to the observation of Cherbonnier (1969).

Wheel ossicles are represented by two types: typical myriotrochid wheels, and wheels with fused spokes. Typical myriotrochid wheels are not common and I could find only five of them. They are very small, only 70-80 µm in diameter (Fig. 5G-I). Parameters of the wheels of myriotrochid type are given in Table 4.

Wheels with fused spokes are represented by Fig. 5A-F. The spokes in this type of wheel are swollen in the middle portion, slightly nearer to the hub than to the rim. Sometimes, these swollen portions are fused leaving small oval holes near the hub. The number of these holes corresponds to the number of fused pairs of spokes and ranges from two up to the total number of spokes (Fig. 5A-D). In the last case a new large hub with a ring of small holes arises (Fig. 5A). These wheels are similar to the wheels of *Myriotrochus bathybius*. The wheels with fused spokes, 160-195 µm in diameter are more abundant, and are larger than myriotrochid wheels. Parameters of the wheels with fused spokes are given in Table 5.

DISCUSSION

The specimen has been previously described by Cherbonnier (1969) as *Myriotrochus* sp. However in the slide collection of Cherbonnier (MNHN

TABLE 5. — Parameters of the wheels of fused type of *Myriotrochus* (*Oligotrochus*) *rotulus* n.sp. See "Methods" for abbreviations.

Parameter	D (µm)	S	T	S/T (%)	Dhp (µm)	Dhp/D (%)	Dhs (µm)	Dhs/D (%)	Lo (µm)	Lo/D (%)	Lt (µm)	Lt/D (%)
	160	15			24	15.0	53	33.1			32	20.0
	160	15	25	60.0	23	14.4	50	31.3			38	23.8
	162	17	26	65.4	28	17.3	53	32.7			38	23.5
	170	17	24	70.8	30	17.6	55	32.4			38	22.3
	170	14	24	58.3	25	14.7	52	30.6			40	23.5
	170	14	24	58.3	25	14.7	50	29.4			38	22.4
	172	16	25	64.0	25	14.5					35	20.3
	175	16	33	18.9								
	180	16	24	66.7	30	16.7	60	33.3	15	8.3	40	22.2
	183	18	27	66.7	28	15.3	60	32.8	17	9.3	45	24.6
	185	17	27	63.0	30	16.2	53	28.6	17	9.2	40	21.6
	185	17	27	63.0	28	15.1	57	30.8			40	21.6
	190	17	26	65.4	25	13.2	55	28.9			38	20.0
	195	18	31	58.1	32	16.4	60	30.8			40	20.5
n	14	14	12	12	14	14	12	12	3	3	13	13
mean	175.5	16.2	25.8	63.3	27.6	15.71	54.8	31.23	16.3	8.94	38.6	22.03
σ	11.1	1.3	2.0	4.0	3.1	1.53	3.7	1.65	1.2	0.53	3.0	1.52

Paris) the slide with the calcareous ossicles of the holotype is labelled as "*M. rotulus*, sp.n.". The specimen itself was stored together with the specimens of *M. vitreus*. Apparently, at first, Cherbonnier was intending to describe the specimen as a new species, but later preferred to describe it without giving a new name, considering it to be close to *M. vitreus*. I prefer to keep the name used on the label by Cherbonnier. The opinion that this specimen belongs to a new species of *Myriotrochus* has been expressed by Belyaev & Mironov (1982, p. 111: "Undoubtedly this is a new species, close to *M. bathybius* Clark in wheel structure").

The specimen described is lacking its anterior end, so it is impossible to determine the number of tentacles. The close resemblance of fused type wheels to wheels with hub perforated by circle of holes, as in *Myriotrochus bathybius* and *M. neocaledonicus* n.sp., clearly points the great similarity between the new species and the species mentioned above. Thus, I prefer to place the new species in the twelve-tentacle genus *Myriotrochus* Steenstrup, 1851, rather than in the ten-tentacle genus *Prototrochus* Belyaev *et* Mironov, 1982, both genera having wheels of the myriotrochid type.

In some wheels, a quarter to third of the total number of teeth are merged with each other (Fig. 5E, F).

M. rotulus differs from all species of *Prototrochus* and *Myriotrochus* in having wheels with "fused spokes" besides wheels of the typical myriotrochid type. In *M. rotulus* these wheels usually have less hub perforations than spokes because not all of the spokes are fused. This character clearly distinguishes the new species from *M. bathybius* and *M. neocaledonicus* (see H. L. Clark 1920; Gage & Billett 1986). *M. rotulus* also differs from these species in having smaller wheels.

KEY TO SPECIES OF THE SUBGENUS *Oligotrochus*

1a. Wheels of typical myriotrochid type with whole hub; ventral pieces of the calcareous ring two times higher than dorsal pieces 2

1b. Wheels with hub penetrated by a completely or partly developed circle of perforations; sometimes typical myriotrochid wheels with whole hub also occur 3

2a. Diameter of wheels 50-90 µm; average S/T ratio 59-61%; tentacles with four to five pairs of lateral digits ..... *M.* (*O.*) *vitreus* M. Sars, 1866

2b. Diameter of wheels 56-244 (mean 122) µm; average S/T ratio 49%; tentacles with two pairs of lateral digits ..... *M.* (*O.*) *clarki* Gage *et* Billett, 1986

3a. Wheels 160-195 µm in diameter with spokes swollen in their middle portion; some of these swollen portions are fused to each other leaving small oval perforations near the hub; the number of these perforations correspond to the number of fused pairs of spokes and ranges from two up to the total number of spokes ... *M.* (*O.*) *rotulus* n.sp.

3b. Wheels 120-450 µm in diameter with hub penetrated by a complete circle of perforations 4

4a. Average ratio Lo/D 6.5-6.7%; tentacles with three to four digits on each side .... *M.* (*O.*) *bathybius* H. L. Clark, 1920

4b. Average ratio Lo/D 4.4%; tentacles do not have (?) lateral digits .... *M. neocaledonicus* n.sp.

CONCLUSION

My own studies on the morphology of wheels and calcareous rings in the genus *Myriotrochus* have convinced me that *M. vitreus* (M. Sars, 1866), *M. clarki* (Gage *et* Billett, 1986), *M. rotulus* n.sp., *M. bathybius* H. L. Clark, 1920 and *M. neocaledonicus* n.sp. are closely related. All these species have conical tentacles bearing small lateral digits of the quasi "peltate" type (except for *M. rotulus*, the head part of this species being unknown) which are quite different from the tentacles of the "peltato-digitate" type characteristic of *M. rinkii*, the type species of the genus *Myriotrochus* and correspondingly the type species of the nominotypical subgenus *Myriotrochus*. Hence, the character proposed by Heding to separate the subgenus *Oligotrochus* characterizes this above mentioned group of species.

The main diagnostic characters used in the taxonomy of the subgenus *Oligotrochus* are the form of the wheels, the calcareous ring structure, and the number of tentacle digits.

The origin of wheels with the hub perforated by a circle of holes, which is typical of *M. bathybius* and *M. neocaledonicus*, is obvious. The large hub with the circle of perforations is the result of the fusing of the swollen middle part of the spokes. One can easily observe this fusion *in statu nascendi* in the wheels of *M. rotulus*. We find all the

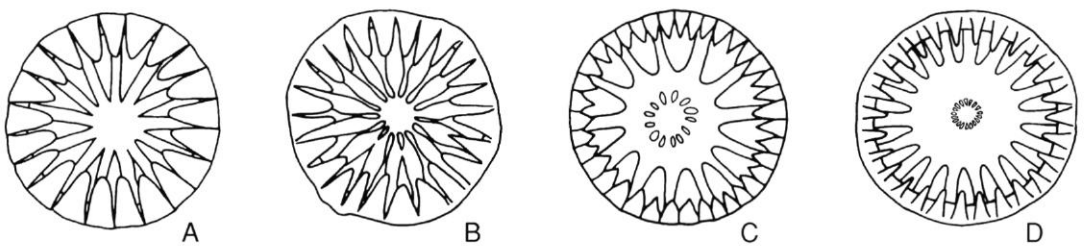

FIG. 6. — A morphological series which illustrates the origin of the wheels with wide hub perforated by a circle of holes; **A**, *Myriotrochus* (*Oligotrochus*) *vitreus* (M. Sars, 1866) (after Heding 1935, fig. 3-1); **B**, *M.* (*O.*) *rotulus* n.sp.; **C**, *M.* (*O.*) *bathybius* H. L. Clark 1920, pl. 4, fig. 3; **D**, *M.* (*O.*) *neocaledonicus* n.sp.

transitional forms, from wheels with only two holes to wheels with a complete circle of perforations (Fig. 5A-D). It is interesting to note that typical myriotrochid wheels also occur in this species, though they are not as abundant as wheels with fused spokes. H. L. Clark (1920: 126-127) found developing wheels in *M. bathybius* and described this process: "When the length of the spokes is somewhat greater than the diameter of the original hub, a swelling appears near the middle of each spoke and as these swellings widen they come in contact and fuse with each other, leaving the circle of small oval holes, which apparently never fill up." In one Northeast Atlantic specimen, Gage & Billett (1986: 236, fig. 4) also found the different stages of development from the typical myriotrochid wheels to wheels with hub perforated by a circle of holes. Thus, the development of wheels typical of *M. bathybius* reflects the origin of wheels with perforated hub. It is also interesting to note that in *M. clarki* Gage & Billett (1986: 252, fig. 16A, B) found that "the large wheels showing fusion of adjacent spokes around the hub, resulting in a greatly enlarged central part of the wheel, are reminiscent of *M. bathybius*. They differ from the latter species in lacking a ring of small oval perforations around the hub." This indicates that species of the subgenus *Oligotrochus* have a tendency to form wheels with wide hub resulting from the fusion of the distal parts of the spokes. Possibly, this process is connected with the large size of the wheels. The material examined allows to describe a morphological series which illustrates the origin of the wheels with wide hub perforated by a circle of holes (Fig. 6). This series can be regarded as a polarized transformation series in the terms of cladistic systematics. The small typical myriotrochid wheels of *M. vitreus* are placed at the beginning of this series. The following stages are represented by the different wheels of *M. rotulus*, which demonstrate all intermediate stages of the fusion of the middle portion of the spokes, a fusion ranging from two to all spokes. The next stage is represented by the wheels of *M. bathybius* which have a complete circle of oval perforations. The wheels of *M. neocaledonicus*, which have a circle of very small triangular perforations, complete the series. A side branch of this morphological series was found in only one specimen of *M. clarki*, which is represented by wheels with wide hub produced by the complete fusion of adjacent spokes around the primary hub.

The calcareous ring having considerable differences in height between the ventral and dorsal pieces, and large posterior processes, which is characteristic of *M. vitreus* and *M. clarki,* is to be regarded as a derived character. This character separates those species from *M. bathybius* and *M. neocaledonicus* which have a more simple structure of the calcareous ring.

A tentacle with three to five pairs of lateral digits is to be considered as a primitive character. Tentacles with one or two pairs of digits, or without digits, is a more advanced character which can be easily derived independently.

Possible phylogenetic relationships of the species of the subgenus *Oligotrochus*, based on wheel shape, difference between dorsal and ventral pieces of the calcareous ring and number of tentacular digits, are represented in Figure 7.

The characters of the calcareous ring and wheel structure indicate that there are two groups of species, the first including *M. vitreus* and *M. clarki*, the second *M. bathybius* and *M. neocaledonicus*. In the first group *M. clarki* is apparently more advanced than *M. vitreus* because the

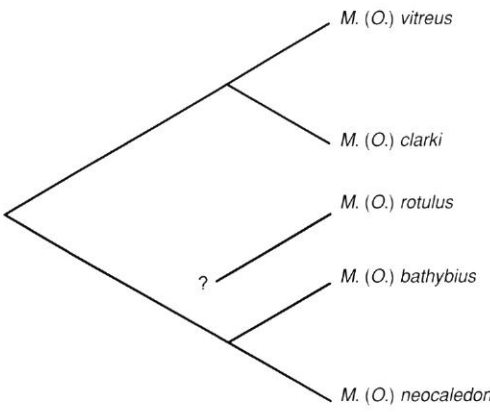

FIG. 7. — Possible phylogenetic relationships of the species of the subgenus *Oligotrochus*, based on wheel shape, difference between dorsal and ventral pieces of the calcareous ring and number of tentacular digits.

former species has larger wheels, sometimes with wide hub, and tentacles with only one or two pairs of digits. In the second group, *M. neocaledonicus* having small triangular holes in the hub of the wheels, and being without lateral tentacle digits (the last character requires confirmation with new material) is apparently more advanced. *M. vitreus* and *M. clarki* seem to be related with *M. bathybius* and *M. neocaledonicus*. The latter pair is characterized by evolved type of wheels with hub perforated by a circle of holes. Nevertheless, the first pair of species, which have primitive wheels, cannot be considered the ancestor of the *M. bathybius-M. neocaledonicus* group because *M. vitreus* and *M. clarki* have the advanced type of calcareous ring. Unfortunately, because the data on the structure of the calcareous ring and tentacles of *M. rotulus* are missing the relationship of this species to others cannot be determined. Wheel characters of *M. rotulus* suggest that it is more closely related to the *M. bathybius-M. neocaledonicus* group.

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REFERENCES

Belyaev G. M. 1970. — Ultra-abyssal holothurians of the genus *Myriotrochus* (order Apoda, fam. Myriotrochidae). *Trudy Instituta Okeanologii* 86: 458-488, pls 1, 2 [in Russian].

Belyaev G. M. & Mironov A. N. 1982. — The holothurians of the family Myriotrochidae (Apoda). *Trudy Instituta Okeanologii* 117: 81-120 [in Russian].

Carney R. S. & Carey A. G. Jr 1976. — Distribution pattern of holothurians of the Northeastern Pacific (Oregon, U.S.A.) continental shelf slope, and abyssal plain. *Thalassia Jugoslavica* 12 (1): 67-74.

Clark H. L. 1907. — The apodous holothurians. *Smithsonian Contributions to Knowledge* 35: 1-231, pls 1-13.

— 1920. — Reports on the scientific results of the expedition to the Tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U.S.N., Commanding. XXII. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer "Albatross" from October, 1904, to March, 1905, Lieut. Commander L. M. Garret, U.S.N., Commanding. XXXIII. Holothurioidea. *Memoirs of the Museum of Comparative Zoology at Harvard College* 39 (4): 121-154, pls 1-4.

Danielssen D. C. & Koren J. 1879. — Fra den norske Nordhavs-expedition. Echinodermer. *Nyt Magazin for Naturvidenskaberne* 25: 83-140.

— 1882. — Holothurioidea, *in The Norwegian North-Atlantic Expedition. Zoology VI*, 95 p., 13 tables, map.

Djakonov A. M. 1933. — Echinodermata of the Northen Seas, *in Keys to the Fauna of the USSR*, 8. Zoological Institute of the Academy of Sciences of the USSR, 166 p. [in Russian].

Gage J. D. & Billett D. S. M. 1986. — The Family Myriotrochidae Théel (Echinodermata: Holothuroidea) in the deep northeast Atlantic Ocean. *Zoological Journal of the Linnean Society of London* 88: 229-276.

Grieg J. A. 1912. — Sognefjordens echinodermer. *Archiv for Mathematik og Naturvidenskab* 32 (11): 1-13.

— 1914. — Bidrag til kundskapen om Hardangerfjordens fauna. *Bergens Museums Aarbok* 1913 (1): 1-147.

— 1928. — Echinodermata. The Folden Fiord. Zoological, hydrographical and quaternary geological observations made in the Folden fiord during the summer of 1923 by Dr O. T. Grønlie and T. Soot-Ryen. *Tromsø Museums Skrifter* 1 (7): 1-11.

Heding S. G. 1931. — Über die Synaptiden des Zoologischen Museums zu Hamburg. *Zoologische Jahrbücher. Abteilung für Systematik, Ökologie und Geographie der Tiere* 61: 637-696, table 11

— 1935. — Holothurioidea. Part I. Apoda, Molpadioidea, Gephyrothurioidea. *The Danish Ingolf-Expedition* 4 (9): 1-84.

Høisæter T. 1990. — An annotated check-list of the echinoderms of the Norwegian Coast and adjacent waters. *Sarsia* 75: 83-106.

Koehler R. 1927. — *Les Échinodermes des mers d'Europe*. Tome second. Librairie Octave Doin, Paris, 339 p., pls 10-18.

Ludwig H. 1889-1992. — *Die Seewalzen. Dr H. G. Bronn's Klassen und Ordnungen des Thier-Reichs, wissenschaftlich dargestellt in Wort und Bild. Zweiter Band. Dritte Abtheilung. Echinodermen (Stachelhäuter).* I. Buch. C. F. Winter'sche Verlagshandlung, Liepzig, 460 p., 17 tables.

Lütken Chr. 1857. — Oversigt over Grönlands Echinodermer. *Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn for Aaret 1857*: 1-55.

Madsen F. J. & Hansen B. 1994. — Echinodermata Holothurioidea. *Marine Invertebrates of Scandinavia* 9, 143 p.

Mortensen Th. 1924. — Pighude (echinodermer). Danmarks Fauna. *G. E. C. Gads Forlag. København*, 274 p.

— 1927. — *Handbook of the Echinoderms of the British Isles.* Humphrey Milford Oxford University Press, London *et al.*, I-IX + 471 p.

Mortensen Th. & Lieberkind I. 1928. —Echinoderma. *Die Tierwelt der Nord- und Ostsee*, 8, 128 p.

Östergren Hj. 1898. — Das System der Synaptiden. *Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar* 55: 111-120.

— 1903. — The Holothurioidea of Northern Norway. *Bergens Museums Aarbog* 1902 (9): 1-34.

— 1938. — Studien über die Seewalzen. *Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handlingar, Femte Följden,* Ser. B, 5 (4): 1-151, tables 1-10.

Salvini-Plawen L. v. 1977 — Caudofoveata (Mollusca), Priapulida und apode Holothurien (*Labidoplax*, *Myriotrochus*) bei Banyuls und im Mittelmeer allgemein. *Vie et Milieu*, série A, 27 (1) : 55-81.

Sars G. O. 1872. — Nye Echinodermer fra den norske Kyst. *Forhandlinger i videnskabs-selskabet i Christiania* 1871: 1-31.

Sars M. 1866. — Om arktiske Dyreformer i Christianiafjorden. *Forhandlinger i videnskabs-selskabet i Christiania* 1865: 196-200.

— 1877. — New echinoderms, *in* Koren J. & Danielssen D. C. (eds), *Fauna litoralis norvegiæ* 3: 49-75, tables 7, 8.

Steenstrup J. 1851. — *Myriotrochus Rinkii* Stp., en ny Form af de lungelöse og fodlöse Söpölsers (Holothuries) Gruppe. *Videnskabelige Meddelelser fra den naturhistoriske i Kjöbenhavn*, for Aaret 1851: 55-60, table III, figs 7-10.

Storm V. 1879. — Bidrag til Kundskab om Trondhjemsfjordens Fauna. *Det Kongelige Norske Videnskabers Selskabs Skrifter.* 1878: 9-36.

Théel Hj. 1886. — Report on the Holothurioidea dredged by H.M.S. "Challenger" during the years 1873-1876. II. *Report of The Scientific Results of the Voyage of H.M.S. "Challenger" 1873-76* 14 (39): 1-299.

Verrill A. E. 1874. — Results of recent dredging expeditions on the Coast of New England. *American Journal of Sciences*, 3 serie, 7: 405-414.

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