

Two new genera of nemertean worms of the family Tetrastemmatidae (Nemertea: Monostilifera)

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Protetrastemma gen. n. (type species *Tetrastemma viridis* Kulikova, 1989) and *Quasitetrastemma* gen. n. (type species *Tetrastemma nigrifrons* Coe, 1904) are established. *Quasitetrastemma stigmatum* (Yamaoka, 1940), comb. n. is reinstated as a valid name.

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The genus *Tetrastemma* Ehrenberg, one of the largest nemertean taxa, is almost certainly non-monophyletic, with many inadequately described species. The generic diagnosis of *Tetrastemma* has been recently modified by Sundberg & Gibson (1995). In this diagnosis, morphological characters used to place species in the genus were summarized as: "monostiliferous hoplonemerteans with four eyes, typically arranged at the corners of a square or rectangle, sometimes multiplied by duplication; rhynchocoel with two distinct muscle layers, extending to, or almost to, posterior end of the body; cephalic glands usually well developed but rarely extending behind cerebral ganglia; cerebral sensory organs small, close to anterior margins of cerebral ganglia; nervous system with neither neurochords nor neurochord cells, without accessory lateral nerves; blood vascular system with three longitudinal vessels, mid-dorsal vessel with single vascular plug; excretory system restricted to anterior region of body, with two or only a few nephridiopores; intestinal caecum present, with anterior diverticula; sexes separate". Since four *Tetrastemma* species do not conform to this diagnosis and cannot be placed in any of the existing tetrastemmatid genera, two new genera are established for them.

All material from Peter the Great Bay was anaesthetized in 7% MgCl₂, fixed in Bouin's solution and subsequently sectioned at 7-8 µm in paraffin wax and stained by the Crandall's modification of the Mallory method. The following abbreviations are used in the descriptions: E – thickness of epithelium, D – thickness of dermis, C – thickness of outer circular muscle layer, L – thickness of longitudinal muscle layer.

Genus **Protetrastemma** gen. n.

Type species: *Tetrastemma viridis* Kulikova, 1989.

Description. Monostiliferous free-living marine nemerteans. Body short; head with four eyes and two pairs of cephalic furrows. Rhynchocoel extending to posterior end of body, with wall containing two muscle layers. Anterior region of proboscis with three muscle layers. Body wall musculature with weakly developed diagonal musculature; longitudinal musculature not anteriorly divided; dorsoventral musculature well developed in intestinal region. Precerebral septum composed of radiating muscle bundles. Frontal organ present. Basophilic cephalic gland well developed, posteriorly reaching brain; submuscular glands numerous, predominantly cephalic. Cerebral sensory organs situated below brain, opening ventrolaterally into anterior pair of cephalic furrows. Cerebral ganglia with outer neurilemma only. Lateral nerve cords without accessory nerves, with myofibrillae. Foregut opening into rhynchodaeum, divisible into oesophagus, stomach and short pyloric region. Intestinal caecum with anterior and lateral pouches; intestine with branched lateral diverticula. Blood system simple; dorsal vessel with short vascular plug; longitudinal vessels without pseudometameric transverse connectives. Excretory system confined to foregut and anterior intestinal regions. Sexes separate.

Included species: type species only.

Comparison. In two tetrastemmatid genera, *Austroprostoma* Stiasny-Wijnhoff, 1942 and *Ammonemertes* Gibson, 1990, like in the present genus, the cerebral organs are located beside the brain. *Protetrastemma* can be distinguished from

these genera by the following features: in *Austroprostoma*, the rhynchocoel extends for about two-thirds of the body length, cerebral organs are enclosed by the outer brain neurilemma and adjacent to lateral and ventrolateral margins of the brain, the blood system possesses transverse pseudometameric connectives, the pyloric portion of the foregut is not developed; in *Ammonemertes*, the cerebral organs open from the posterior pair of the cephalic furrows, the pyloric portion of the foregut is not developed, the intestinal caecum has no lateral pouches. In addition to these features, the new genus differs from both *Austroprostoma* and *Ammonemertes* in the longer nephridial tubules, extending throughout foregut and anterior midgut region.

Protetastemma viride (Kulikova, 1989), comb. n. (Figs 1, 2)

Tetrastemma viridis Kulikova, 1989: 628-630, figs 1, 2.
Tetrastemma kulikovae Gibson, 1995: 527.
Tetrastemma viride: Chernyshev, 1998: 995.

Type material examined. Paratype no. Jd-24 (Zoological Museum of Moscow State University), immature ♀, 2 slides with transversal sections, *Sea of Japan*, Peter the Great Bay, Vostok Bay, depth 1 m, on *Phyllospadix iwantensis*, 1.X.1985 (V. Kulikova).

Other material examined. 1 mature ♀, 4 slides with transversal sections, the same locality as for paratype, depth 0.5 m, on *Phyllospadix* sp., 9.VII.1988 (A. Chernyshev); body length of the living specimen was 11-12 mm.

Description of internal organization. Body wall: paratype: E = 13-38 µm, D = 1-2 µm, C = 4-6 µm, L = 5-34 µm (in stomach region); E = 16-41 µm, D = 1 µm, C = 2-10 µm, L = 5-39 µm (in middle body region); mature female: E = 36-80 µm, D = 3-5 µm, C = 4-11 µm, L = 21-43 µm (in stomach region); E = 48-80 µm, D = 1.5-3 µm, C = 3-9 µm, L = 9-35 µm (in middle body region). Separate diagonal muscles weakly developed. Dorsoventral musculature 3-8 fibers in thickness, situated between intestinal pouches and branches. Parenchyma moderately developed, particularly in cerebral and foregut region. Precerebral septum consists of 10-11 radial muscle bundles; dorsal and dorsolateral bundles anterior to ventral and ventrolateral. Epithelium of rhynchodaem glandular. Proboscis with 10 nerves; inner circular muscle layer very thin. Oesophagus with unciliated and glandular epithelium, surrounded by very thin layer of longitudinal muscles. Just behind brain, stomach with dorsal protrusion (60-85 µm long in mature female); epithelium of stomach glandular, ciliated and folded. Pylorus 0.48-0.52 times as long as stomach. Short intestinal caecum with 1-2 pairs of branched lateral pouches; a pair of anterior pouches reaches dorsal ganglia. Anterior pouches of mature female branched and voluminous.

Dorsal brain commissure anterior to ventral. Giant neurochord cell not found in brain, but each lateral nerve cord with single neurochord-like structure. This structure unstained, 5-19 µm in diameter, situated between fibrous core and ganglionic tissue. Two-jointed nerves extend from each ventral part of brain to cerebral organs. 6-8 cephalic nerves situated between cephalic and submuscular glands. Canals of cerebral organs ciliated, not branched, with septum in middle portion. Anterior portion of canal wider, opens lateroventrally (5 and 7 o'clock positions) at level of ventral (paratype) or dorsal (mature female) cerebral commissure and leads directly inwards, then turns through 90° posteriorly. Cerebral organs with two lateral (inside and outside) groups of acidophilic glandular components. Inside group extends behind end of cerebral canal and forms very short process. Frontal organ of mature female about 55 µm in diameter. Basophilic cephalic gland compact and well developed in precerebral region. Just behind rhynchopore, three lobes (one dorsal and two lateral) of cephalic glands extend along anterior part of rhynchodaem. These lobes coalescing and arched over rhynchodaem. In posterior portion, cephalic gland divided into two lateral lobes. Numerous small submuscular glands faintly orange-stained by Mallory method, well developed in precerebral region and distinct from cephalic gland. Isolated submuscular glands extend back to stomach region.

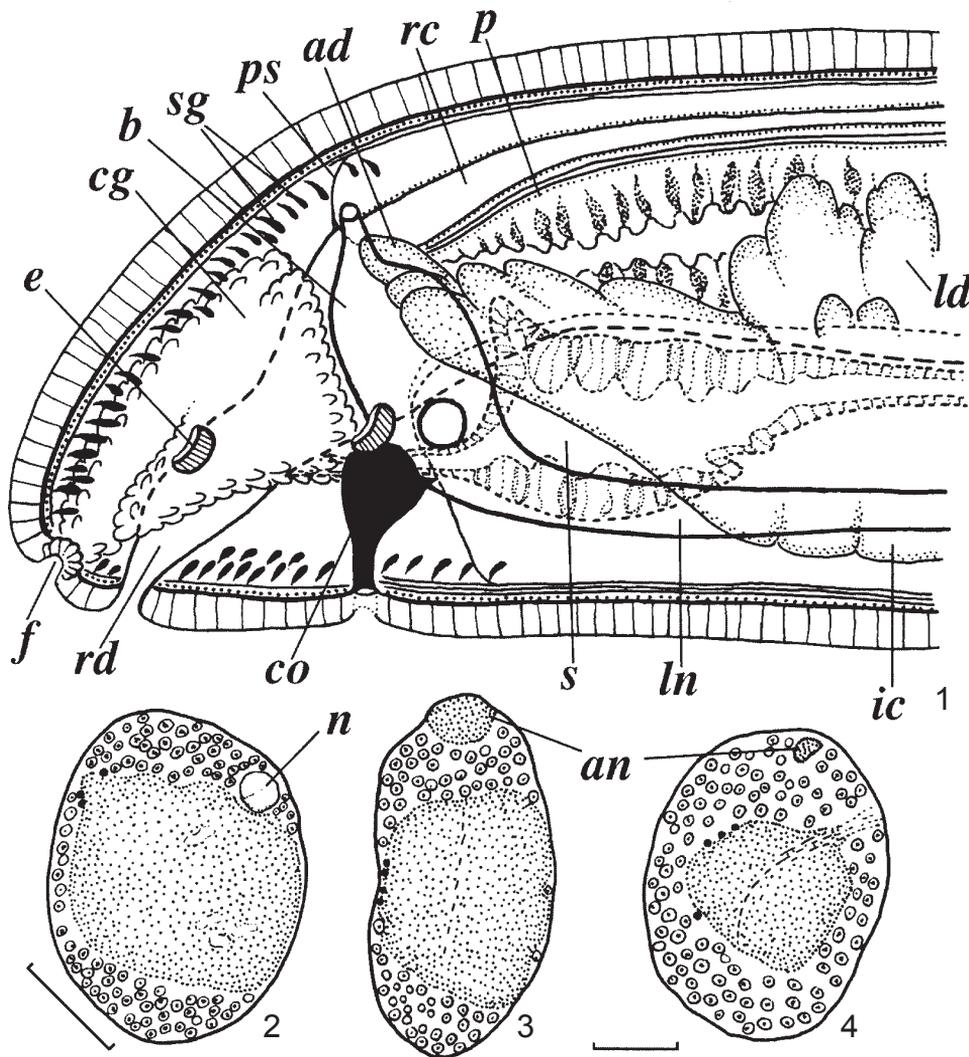
Vascular plug situated just behind ventral brain commissure. Excretory system extends from just behind brain to anterior portion of intestine. In foregut region, 2-4 collecting tubules situated closely to each lateral nerve cord; long efferent duct opens via a pair of lateroventral nephridiopores. In anterior intestinal region (1/5-1/6 of total length of midgut), slender collecting tubule situated close to internal margin of each lateral nerve cord. In mature female, ovaries occur singly along dorsolateral borders of body between intestinal diverticula. Most ovaries with single egg (up to 250 µm in diameter) and short dorsolateral gonoduct.

Remark. The name *Tetrastemma kulikovae* suggested by Gibson (1995) is not valid. *Tetrastemma viridis* Kulikova, 1989 is neither a primary nor secondary homonym of *Fasciola viridis* Müller, 1774, as the latter has belonged to the genus *Lineus* and there was no nominal taxon *Tetrastemma viride* Oersted, 1844.

Quasitetastemma gen. n.

Type species: *Tetrastemma nigrifrons* Coe, 1904.

Description. Monostiliferous free-living marine nemerteans. Body slender, head with 4 (rarely



Figs 1-4. 1, 2, *Protetrastemma viride* (Kulikova); 3, *Quasitetrastemma nigrifrons* (Coe); 4, *Asteronemertes gibsoni* Chernyshev. Scheme of anterior body portion in lateral view (1), scheme of transversal section of the right lateral nerve cord (2-4). *ad*, anterior diverticula of caecum; *an*, accessory nerve; *b*, brain; *cg*, cephalic gland; *co*, cerebral organ; *e*, eye; *f*, frontal organ; *ic*, intestinal caecum; *ld*, lateral diverticula of caecum; *ln*, lateral nerve cord; *n*, neurochord-like structure; *p*, proboscis; *ps*, precerebral septum; *rc*, rhynchocoel; *rd*, rhynchodaeum; *s*, stomach; *sg*, submuscular glands. Scale: 20 μ m.

5-8) eyes and two pairs of cephalic furrows. Rhynchocoel up to 90-100% of body length, with wall containing two muscle layers. Anterior region of proboscis with three muscle layers (inner circular layer very thin). Body wall musculature with weakly developed diagonal musculature; longitudinal musculature not divided behind brain; dorsoventral musculature present. Precerebral septum acclivous, joins with body wall longitudinal musculature just behind brain. Fron-

tal organ present. Basophilic cephalic gland and acidophilic submuscular glands in precerebral region. Cerebral sensory organs large, situated at short distance in front of rhynchodeal sphincter. Cerebral ganglia with outer neurilemma only, without neurochord cells. Lateral nerve cords with small accessory nerves and myofibrillae. Foregut opening into rhynchodaeum, divisible into oesophagus, stomach and long pyloric region. Intestinal caecum with anterior and lateral

pouches; intestinal lateral diverticula simple or with short lobes. Blood system simple; dorsal vessel with short vascular plug; longitudinal vessels without pseudometameric transverse connectives. Blood cells with red pigment. Excretory system extends from rear of brain to pylorus. Sexes separate.

Included species (all transferred from the genus *Tetrastemma*): *Quasitetrastemma nigrifrons* (Coe, 1904), comb. n., *Q. stigmatum* (Yamaoka, 1940), comb. n., *Q. bicolor* (Coe, 1901), comb. n. *Tetrastemma insolens* Iwata, 1952 should possibly also be assigned to this genus.

Comparison. Among tetrastemmatid genera (*Tetrastemmatidae* s. str.), only *Asteronemertes* Chernyshev, 1991 and *Quasitetrastemma* gen. n. possess both accessory nerves in the lateral nerve cords and weakly developed diagonal musculature in the body wall. In *Asteronemertes*, however, the accessory nerve is extremely short and small (Fig. 4), precerebral septum radial, rhynchocoel extends for 50-70% of the body length, well-developed basophilic cephalic gland reaches behind the brain and is associated with deeply stained acidophilic glands in stomach region, intestinal caecum without pouches, dorsal blood vessel without vascular plug.

Quasitetrastemma nigrifrons (Coe, 1904), comb. n. (Figs 3, 5)

Tetrastemma nigrifrons Coe, 1904: 159-164, pl. XVI, figs 6, 7, pl. XX, fig. 16, pl. XXI, figs 15-23.

Material. About 150 specimens: **Russia**, *Sea of Japan* (Peter the Great Bay, Tatar Strait, Moneron Island), *Kuril Islands* (Kunashir Island); **Republic of Korea**, *Sea of Japan* (Yongil Bay). 4 specimens of variety *spadix* were sectioned.

The external characters and internal morphology of this species were described by Coe (1904, 1905), Yamaoka (1940), Iwata (1954) and Chernyshev (1998). The American and Asian populations are fully isolated and differ in some colour varieties: vars. *purpureum* Coe, 1904 and *zonatum* Coe, 1940 are known only from American waters, vars. *spadix* Iwata, 1954, *bilineatum* Iwata, 1954, *punctatum* Iwata, 1954, *albino* Manchenko & Kulikova, 1996, *bimaculatum* Chernyshev, 1998, *trimaculatum* Chernyshev, 1998, *aequicolor* Chernyshev, 1998 are known only from Asian waters. Only the variety *bicolor* Coe, 1904 was found in coastal waters of both North America and Asia. Manchenko & Kulikova (1996) made an electrophoretic investigation of the five main varieties of *T. nigrifrons* and did not find any significant difference between them in 19 enzyme loci.

Additional data on internal morphology. In brain region, muscles of well-developed precerebral

septum similar to inner longitudinal musculature of species of the family Poseidonemertidae, but joins with body wall longitudinal musculature just behind brain. Regular splitting of longitudinal body wall musculature not found. Dorsoventral muscles distinct in stomach region, but reduced in intestinal region. Pylorus 2.6-2.8 times as long as stomach. Anterior pouches of intestinal caecum extend nearly to posterior end of brain. Rhynchodaeum with well-developed sphincter of circular musculature. Proboscis with 10 or 11 nerves. Accessory nerves of longitudinal nerve cords 11-18 μm in diameter, distinct in foregut region (Fig. 3). Basophilic cephalic gland consists of dorsal and ventral lobes. Submuscular glands granular and strongly acidophilic.

Quasitetrastemma stigmatum (Yamaoka, 1940), comb. n.

Prostoma stigmatum Yamaoka, 1940: 251-253, pl. 6, fig. 13, textfigs 30, 31 (non *Tetrastemma stigmatum* Stimpson, 1857).

Tetrastemma stimpsoni Chernyshev, 1992: 135.

Material. About 100 specimens from **Russia**: *Sea of Japan* (Peter the Great Bay), *Kuril Islands* (Kunashir Island), *South Sakhalin* (Aniva Bay).

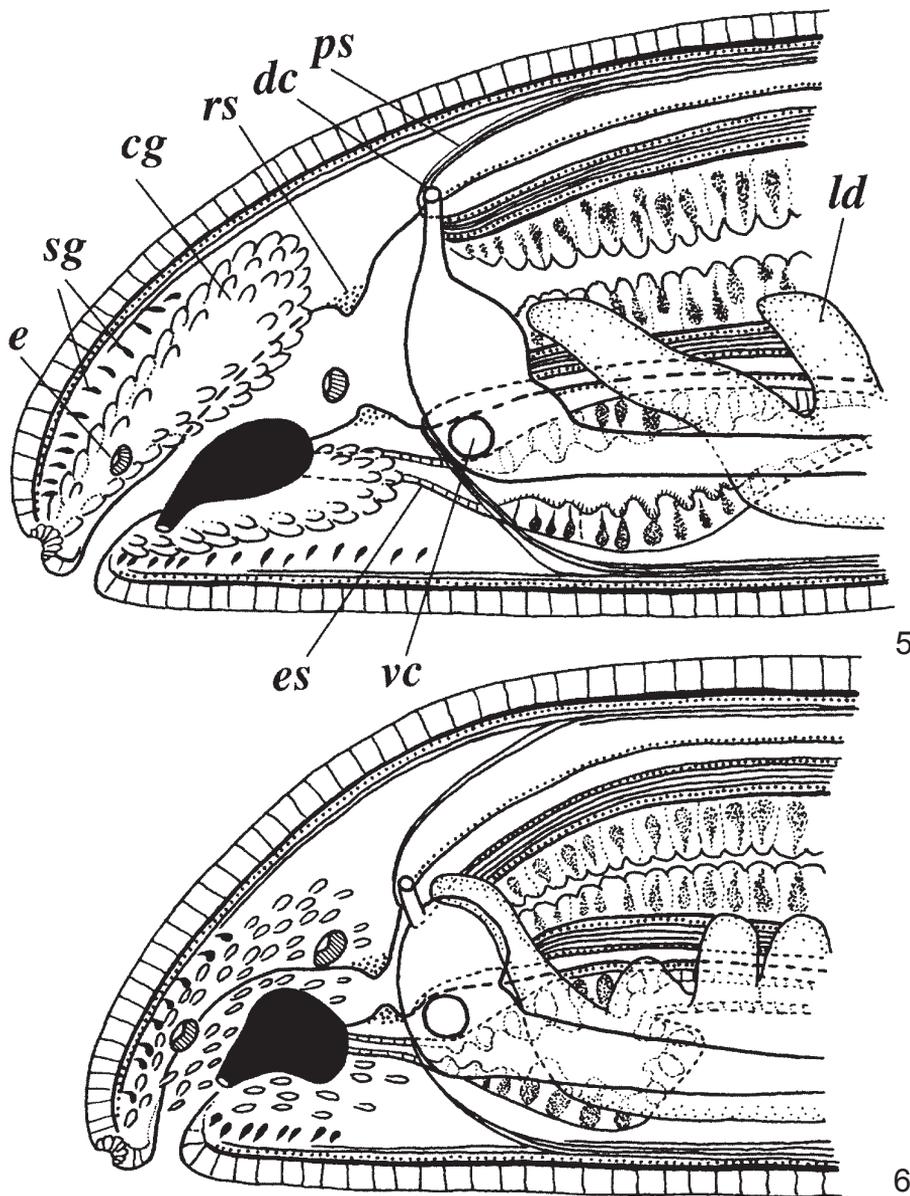
Since *Tetrastemma stigmatum* Yamaoka possesses short accessory nerves of the longitudinal nerve cords, acclivous precerebral septum and red pigmentation of the blood cell, it is clear that this species belongs to the genus *Quasitetrastemma*. *Q. nigrifrons* and *Q. stigmatum* can be clearly distinguished by the body coloration (Chernyshev, 1998). The internal morphology of both species is very similar, but anterior pouches of the intestinal caecum are longer in *Q. stigmatum*.

Remarks. In accordance with Article 60 of the International Code of Zoological Nomenclature, *Prostoma stigmatum* Yamaoka, 1940 was replaced by a new name *Tetrastemma stimpsoni* (Chernyshev, 1992). *Prostoma stigmatum* Yamaoka and *Tetrastemma stigmatum* Stimpson are now not treated as congeneric, and *stigmatum* Yamaoka, 1940 is to be reinstated as the valid name with *Tetrastemma stimpsoni* Chernyshev, 1992 as a junior objective synonym (Art. 59.4).

Quasitetrastemma bicolor (Coe, 1901), comb. n. (Fig. 6)

Tetrastemma bicolor Coe, 1901: 57-58, pl. I, fig. 6.

Material. 24 specimens from **Russia** (*Kamchatka*: Avacha Bay; *Commander Islands*) and **USA** (*St. George Island*); one specimen from the Commander Islands was sectioned.



Figs 5-6. 5, *Quasitetrastemma nigrifrons* (Coe); 6, *Q. bicolor* (Coe). Scheme of anterior body portion in lateral view. *cg*, cephalic gland; *dc*, dorsal commissure of brain; *e*, eye; *es*, oesophagus; *ld*, lateral diverticula of caecum; *ps*, pre-cerebral septum; *rs*, rhynchodeal sphincter; *sg*, submuscular glands; *vc*, ventral commissure of brain.

After the original description, this species has not been reinvestigated using serially sectioned material.

Description of internal organization. Body wall: E = 40-67 μm, D = 3-8 μm, C = 3-8 μm, L = 27-44 μm (stomach region); E = 42-64 μm, D = 3-6 μm, C = 5-9 μm, L = 30-64 μm (intestinal region). Precerebral septum acclivous, joins

with body wall longitudinal musculature just behind brain. Rhynchodaeum with well-developed sphincter of circular musculature. Proboscis well developed, with 12 nerves. Dorsoventral muscles weakly developed in intestinal region. Stomach with deeply folded epithelium. Pylorus broad and flattened, about 2.6 times as long as stomach, emerges from dorsomedian fold

at back of stomach. Anterior diverticula of intestinal caecum extend forward to dorsal portion of brain. Accessory nerves of longitudinal nerve cords short and indistinct. Basophilic cephalic gland diffuse; ventral lobe not distinct. Vascular plug situated behind ventral brain commissure. In stomach region, excretory tubules open via a pair of ventrolateral nephridiopores.

As *Tetrastemma bicolor* Coe possesses short accessory nerves of the longitudinal nerve cords, acclivous precerebral septum and red pigmentation of the blood cell, this species should be transferred to the genus *Quasitetrastemma*. *Q. bicolor* differs from other species of the genus in the body colour (Chernyshev, 1998) and indistinct ventral lobe of the cephalic glands.

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