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ON THE CENTROHELID AND ROTOSPHAERID HELIOZOA FROM THE ENVIRONS OF THE VÕRTSJÄRV LIMNOLOGICAL STATION IN ESTONIA

Abstract. An examination of centrohelid and rotosphaerid Heliozoa in the environs of the Võrtsjärv Limnological Station was performed. Nine species of Centrohelida and one of Rotosphaerida were recorded and illustrated by scanning electron microscopy. Eight species are new to the fauna of Estonia.

A new subspecies *Choanocystis perpusilla heterospina* is described. It is characterized by the diameter 12—14 μm, having two types of spine scales (the length of the long ones exceeds the diameter of body) and plate scales with a noticeably depressed central area.

The introduction of the electron microscope (EM) in taxonomic investigations of scale-bearing planktonic microorganisms during the last three decades has caused a drastic increase in the number of species in these taxa. The greater part of the heliozoan ordos Centrohelida (Centroheliozoa *sensu* Dürrschmidt and Patterson, 1987) and Rotosphaerida are characterized by a species-specific ultrastructure of scales. Therefore the number of known species in these groups increased from 1968 to 1988 more than twice (Roijackers, 1988).

Fourteen species of Heliozoa have been recorded in Estonia (Самсоновъ, 1906; Levander, 1920; Jacobson, 1928). They are *Actinophrys sol*, *Actinosphaerium eichhorni* (Actinophyrida), *Heterophrys fockii*, *H. glabrescens*, *Raphidiophrys intermedia*, *Acanthocystis turfacea*, *A. myriospina*, *A. pertyana*, *A.* sp., *Choanocystis aculeata*, *Raphidocystis* sp. (Centrohelida), *Clathrulina elegans*, *E. cienkowskii* (Desmothoracida), and *Wampyrella lateritia* (inc. sed.).

This paper is based on the observations on the Heliozoa, which were conducted at the Võrtsjärv Limnological Station in southeast Estonia in August—September 1992.

Materials and methods

The plankton samples were collected by nets (10—20 μm mesh diameter) at the following sites (Fig. 1): *1* — River Emajõgi in Tartu near the market hall (riverside vegetation of *Sagittaria sagittifolia*, *Butomus umbellatus*, *Potamogeton perfoliatus*); *2* — eutrophic dam-lake Männijärv in the town of Elva (littoral vegetation of *Hippuris vulgaris*, *Nuphar lutea*, *Sagittaria sagittifolia*, *Potamogeton natans*); *3* — quagmire Lake Valguta Valgjärv (*Hippuris vulgaris*, *Thelypteris palustris*, *Utricularia*

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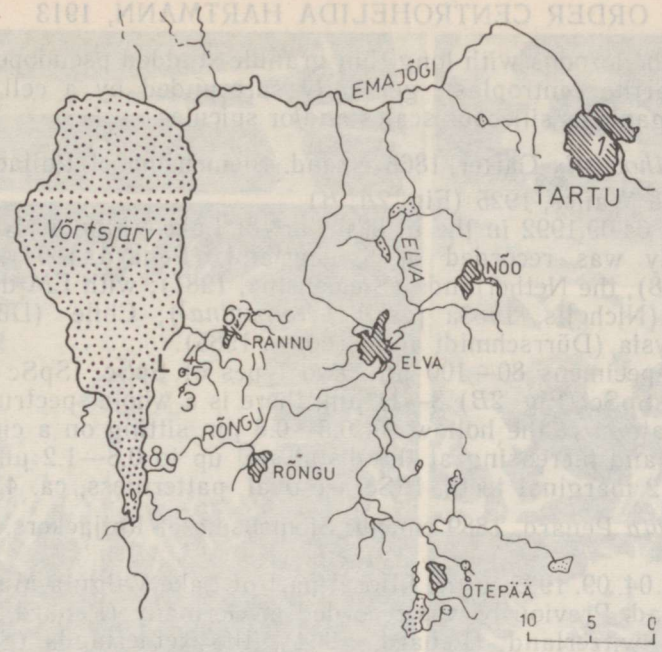

Fig. 1. The region of investigations. *L* — Võrtsjärv Limnological Station; the numbers of sample sites (see Materials and methods) are designated by figures.

vulgaris, *Nuphar lutea*); *4* — central part (*Nuphar pumila*, *Potamogeton lucens*) and *5* — littoral zone (*Potamogeton natans*) of the shallow dyseutrophic Lake Valguta Mustjärv (bottom covered with brown mud); *6* — vegetation of *Lemna trisulca*, *Utricularia vulgaris*, *Sagittaria sagittifolia*, *Potamogeton natans* and 7 — vegetation of *Elodea canadensis*, *Lemna trisulca* and *Utricularia vulgaris* in the littoral part of a large hypereutrophic pond in the Village Rannu; *8* — vegetation of *Elodea canadensis* and *Utricularia vulgaris* and *9* — vegetation of *Carex* sp., *Sagittaria sagittifolia* and *Utricularia vulgaris* in a riverside zone in the lower part of River Uus-Rõngu.

Fresh collected material was investigated by light microscopy within a few hours of sampling; living cells were isolated, fixed with formalin, washed in distilled water and then air-dried on small pieces of glass; the latter were glued on aluminium stubs, coated with a gold-palladium mixture and viewed, using a scanning electron microscope HITACHI S-405A.

Results and observations

Nine species of Centroheliozoa and one of Rotosphaerida were discovered. Among them seven species were recorded first for Estonia and a new subspecies *Choanocystis perpusilla heterospina* ssp. nov. was described.

The following abbreviations will be used in the observations on the heliozoan scale structure: Sc — scale; SpSc and PlSc — spine and plate Sc; lSpSc and sSpSc — long and short SpSc; BPl — basal plate; Sh — shaft of SpSc; BW and LW — basal and lateral wings of SpSc.

ORDER CENTROHELIDA HARTMANN, 1913

Includes heliozoons with long thin granule-studded pseudopods arising from a tripartite centroplast; generally surrounded by a cell coat consisting of organic or siliceous scales and/or spicules.

Genus *Acanthocystis* Carter, 1863 emend. Siemensma et Roijackers, 1988

1. *A. penardi* Wailes, 1925 (Fig. 2*A*, *B*)

Collected 04.09.1992 in the littoral part of Lake Valguta Mustjärv (*5*).

Previously was recorded in Switzerland (Penard, 1904), Germany (Rainer, 1968), the Netherlands (Siemensma, 1981); with EM descriptions in Canada (Nicholls, 1983a [as *A. heterospina*]), Chile (Dürrschmidt, 1985), Malaysia (Dürrschmidt and Croome, 1985).

Studied specimens 80—100 μm; two types of SpSc. lSpSc (Fig. 2*A*) 29—33 μm; sSpSc (Fig. 2*B*) 8—11 μm; there is a whole spectrum of SpSc of intermediate size; the hollow Sh 0.5—0.8 μm sitting on a circular BPl 2.0—3.3 μm and increasing at the distal end up to 0.8—1.2 μm and possessing 8—12 marginal teeth. PlSc are oval, patternless, ca. 4.3×1.8 μm.

2. *A. pectinata* Penard, 1889 emend. Siemensma et Roijackers, 1988 (Fig. 2*C*, *D*).

Collected 04. 09. 1992 in the littoral part of Lake Valguta Mustjärv (*5*).

Widespread. Previously was recorded in Germany (Penard, 1889; Rainer, 1968), Switzerland (Penard, 1904), the Netherlands (Siemensma, 1981); with EM descriptions in Japan (Takahashi, 1959 [as microplankton sp. No. 491]), Australia (Croome, 1986), Chile, New Zealand, Malaysia and Sri Lanka (Dürrschmidt, 1987).

Studied specimens conform to the emended diagnosis and differ outwardly only in the number of lSpSc (Fig. 2*C*). Cells 15—17 μm. lSpSc 4.4—4.8 μm; Sh ca 0.23 μm, increases at the distal end up to 0.35—0.45 μm; the apex possesses 5—6 marginal teeth. sSpSc 2.1—2.4 μm; Sh ca 0.19 μm; the apex is rosette-like, 0.7—0.85 μm, with 5—6 marginal teeth too (Fig. 2*D*). PlSc ca 2.5×1.1 μm, with some medial constriction (ca 0.9 μm).

Genus *Choanocystis* Penard, 1904 emend. Siemensma et Roijackers, 1988

3. *Ch. aculeata* (Hertwig et Lesser, 1874) (Fig. 2*E*, *F*)

Collected 05. 09. 1992 in the large pond at Rannu (*7*) and 07. 09. 1992 in the lower part of River Uus-Rõngu (*8*).

Cosmopolitan species. Previously was recorded in Germany, Switzerland, the Netherlands, Sweden, Canada, Chile, Argentina, Australia, Malaysia (see Page and Siemensma, 1991), the Ukraine (Полищук, 1976) and Estonia (Jacobson, 1928; swamp pool at Nõo).

Studied specimens are similar to previously given EM descriptions (Nicholls, 1983a; Dürrschmidt, 1985; Croome, 1986; Siemensma and Roijackers, 1988a). Cells ca 50 μm. SpSc are of similar size, 7—8×0.4 μm (decrease towards the distal end up to 0.2 μm); proximal part of the Sh ornate with some nodules and papillae. PlSc are dumbbell-shaped, ca 3.3×2.2 μm, with a marked medial constriction 0.8—1.0 μm.

4. *Ch. perpusilla* (Petersen et Hansen, 1960) ssp. *heterospina* ssp. nov. (Fig. 2*G*, *H*, *I*).

Diagnosis. Cell 12—14 μm. Two types of SpSc. lSpSc 14—15 μm, with a thin and straight Sh ca 0.23 μm in diameter, without narrowing, seated on a heart-shaped BPl; an apex with two small teeth. sSpSc 6—7 μm, sometimes slightly curved and resembling SpSc of ssp. *perpusilla*; Sh ca 0.18 μm; an apex with 2 small teeth. PlSc are oval, 5.4—5.9×1.3—1.6 μm, with a large noticeably depressed central area and well-developed axial longitudinal thickening (Fig. 2*H*).

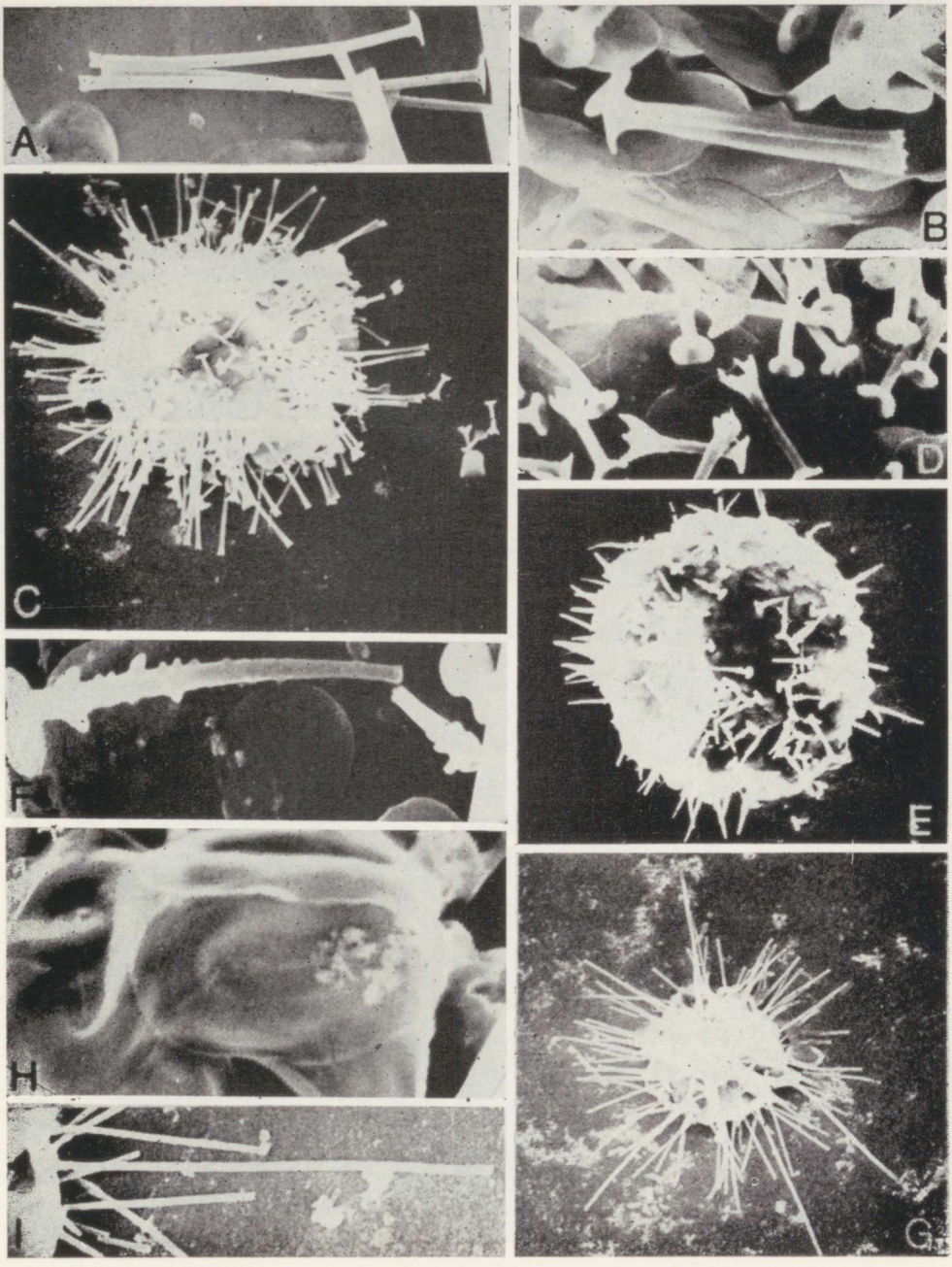

Fig. 2*A*, *B*. *Acanthocystis penardi*. *A*. Long spine scales, 1350×. *B*. Short spine and plate scales, 3600×. Fig. 2*C*, *D*. *Acanthocystis pectinata* *C*. Whole cell, air dried, 1800×. *D*. Scales, 6750×. Fig. 2*E*, *F*. *Choanocystis aculeata*. *E*. Whole cell, air dried, 900×. *F*. Spine scale, 6750×. Fig. 2*G*, *H*, *I*. *Choanocystis perpusilla* ssp. *heterospina*. *G*. Whole cell, air dried, 1350×. *H*. Plate scales, 1350×. *I*. Two types of spine scales, 3200×.

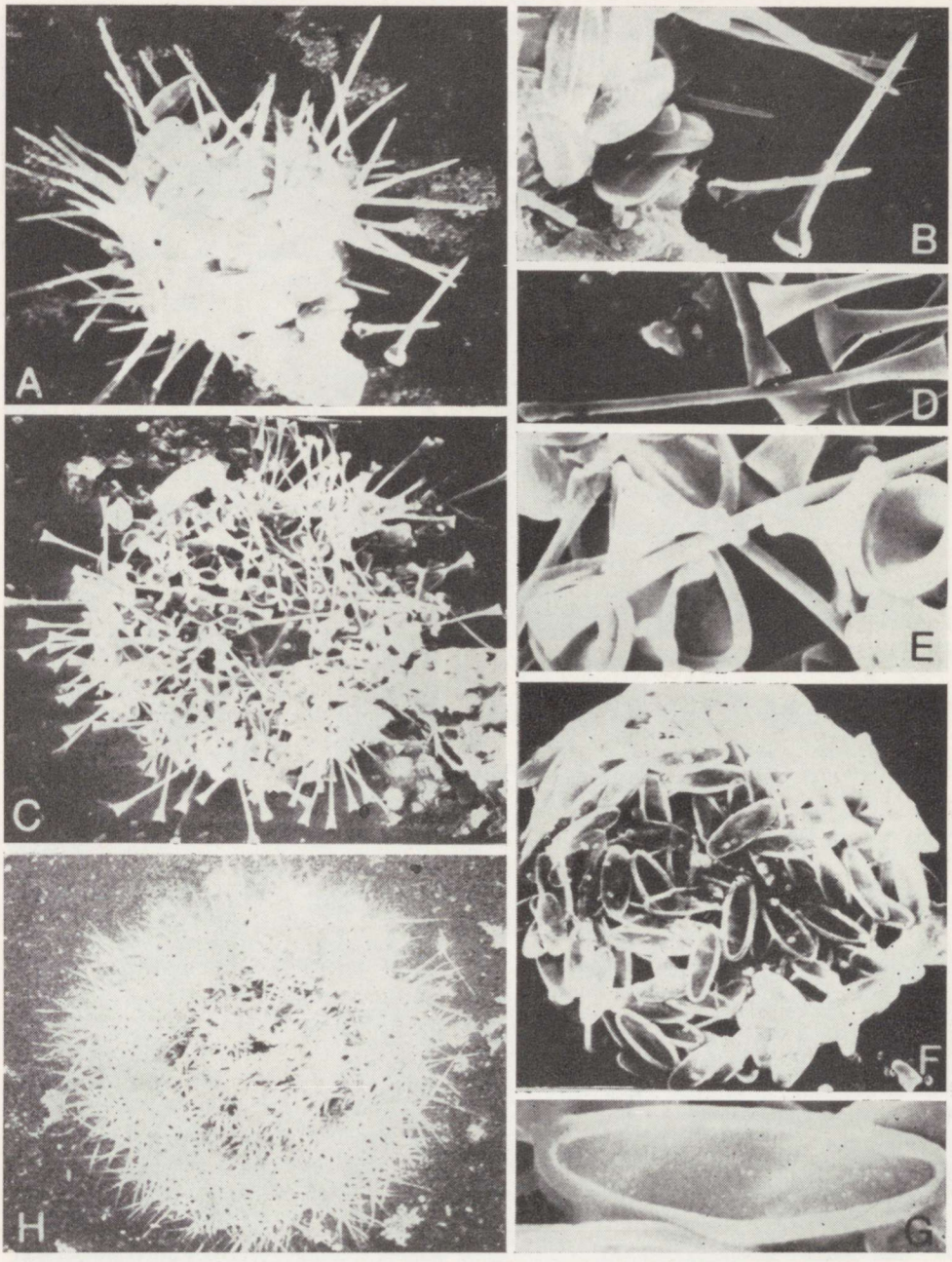

Fig. 3*A, B. Pterocystis erinaceoides. A.* Whole cell, air dried, 1800×. *B.* Plate and spine scales, 3200×. Fig. 3*C, D, E. Raphidocystis tubifera. C.* Whole cell, air dried, 900×. *D.* Scale 1, 2700×. *E.* Scales 2 and 3 (plate scale), 6750×. Fig. 3*F, G. Raphidiophrys marginata. F.* Whole cell, air dried, 900×. *G.* Scale, 6750×. Fig. 3*H. Heterophrys* cf. *fockii.* Whole cell, air dried, 1350×.

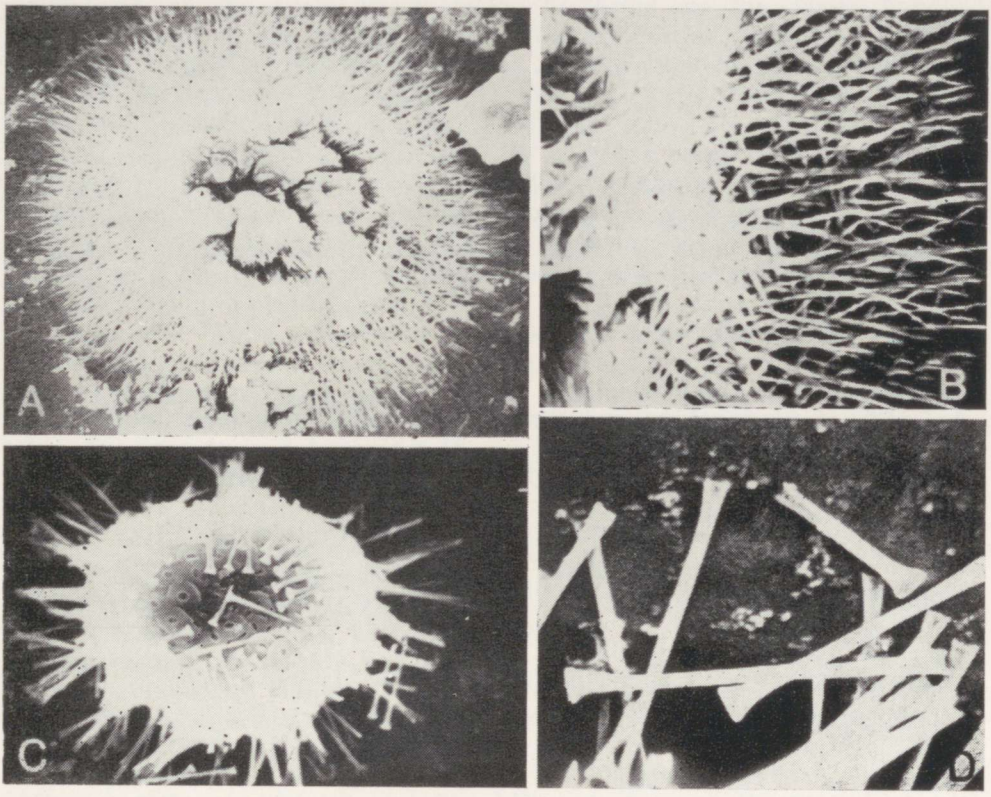

Fig. 4*A*, *B*. *Heterophrys* cf. *myriopoda*. *A*. Whole cell, air dried, 1800×. *B*. Spicules, 5400×.
Fig. 4*C*, *D*. *Rabdiophrys anulifera*. *C*. Whole cell, air dried, 1800×. *D*. Different spine scales, 6750×.

Habitat of the type. Fresh-water. Collected in the large hypereutrophic pond in the village Rannu (Tartu District; Estonia); littoral sample in clumps of *Elodea canadensis*, *Lemna trisulca*, *Utricularia vulgaris* 05. 09. 1992. Similar organisms were collected 07. 09. 1992 in the lower part of River Uus-Rõngu (*9*).

Type micrographs. Fig. 2*G*, *H*, *I* (Fig. 2*H*, *I* being details of scales scattered around the periphery of the cell illustrated in Fig. 2*G*).

Remarks. Differs from *Ch. perpusilla* ssp. *perpusilla* in having in periplast lSpSc exceeding the diameter of the body, while sSpSc are similar to SpSc in the type subspecies (EM descriptions by Petersen and Hansen, 1960; Dürrschmidt, 1985; Croome et al., 1987), and by a larger size. The proportions of lSpSc are similar to SpSc of *Ch. cordiformis*, but *Ch. p. heterospina* differs by having short SpSc and by the presence of two teeth at the apex of SpSc. There is some similarity with *Acanthocystis* sp. from a small pool near Narva-Jõesuu described by Jacobson (1928); the latter is characterized by being 16 μm in diameter and by having two types of SpSc: long — 15 μm and short — 4 μm.

Genus *Pterocystis* Siemensma et Roijackers, 1988

5. *P. erinaceoides* (Petersen et Hansen, 1960) (Fig. 3*A*, *B*)

Collected 05. 09. 1992 in the large pond at Rannu (*7*) and 07. 09. 1992 in the lower part of River Uus-Rõngu (*9*).

Widespread. Previously was recorded (with EM descriptions) in Denmark (Petersen and Hansen, 1960), Germany (Bardele, 1976), the Netherlands (Siemensma, 1981), Canada (Nicholls, 1983a), Chile (Dürrschmidt, 1985) and Australia (Croome, 1986).

Collected specimens correspond to the diagnosis. Cells 17—22 μm. SpSc 5.3—9.7 μm; BW 1.2—1.4 μm; LW extend along the Sh till about one third of its length; Sh ca 0.3 μm, narrowing to the obtuse apex. PlSc oviform, 4.1—4.4×1.6 μm, with developed axial thickening.

Genus *Raphidocystis* Penard, 1904

6. *R. tubifera* Penard, 1904 (Fig. 3*C*, *D*, *E*)

Collected 05. 09. 1992 in the large pond at Rannu (*6*).

Widespread. Previously was recorded in Switzerland (Penard, 1904), Germany (Rainer, 1968), England (Wailes, 1939), the Netherlands (Siemensma, 1981); with EM descriptions in Canada (Rees et al., 1980), Chile, Malaysia, New Zealand and Sri Lanka (Nicholls and Dürrschmidt, 1985), Australia (Croome, 1986).

Only one specimen was collected. Cell 23 μm. Sc-1 (Fig. 3*D*) are trumpet-shaped, 9.6—10.5 μm long; Sh ca 0.4 μm; distal end ca 1.3 μm. Sc-2 (Fig. 3*E*) are funnel-shaped, 2.2—2.5 μm long; basal part ca 0.5 μm; distal part 2.1—2.3 μm in diameter surrounded by a rim 0.26—0.30 μm. PlSc are oval, 4.3—4.8×1.8—2.0 μm, surrounded by a broad peripheral rim 0.15—0.18 μm.

Genus *Raphidiophrys* Archer, 1867

7. *R. marginata* Siemensma, 1981 (Fig. 3*F*, *G*)

Collected 04. 09. 1992 in the central part of Lake Valguta Mustjärv (*4*) and 05. 09. 1992 in the large pond at Rannu (*6*).

Previously was recorded in the Netherlands (Siemensma, 1981), Canada, Chile, New Zealand and Sri Lanka (Nicholls and Dürrschmidt, 1985). EM descriptions in Nicholls and Dürrschmidt (1985), Siemensma and Roijackers (1988b).

Cell diameter is twice as big as in the type material, 27—46 μm. Sc 6.1—6.9×2.2—2.5 μm, surrounded by a peripheral rim ca 0.4 μm.

Genus *Heterophrys* Archer, 1869 emend. Hertwig et Lesser, 1874

8. *H.* cf. *fockii* Archer, 1869 (Fig. 3*H*)

Collected 31.08.1992 in the riverside macrophytes of River Emajõgi in Tartu (*1*), 02.09.1992 in Lake Männijärv in the town of Elva (*2*), 03.09.1992 in Lake Valguta Valgjärv (*3*) and 05.09.1992 in the large pond at Rannu (*6*).

Previously was recorded in Ireland (Archer, 1869), Great Britain (West, 1901), Switzerland (Penard, 1904), Germany (Hertwig and Lesser, 1874; Rainer, 1968), the Netherlands (Siemensma, 1981), Estonia (Jacobson, 1928; Narva-Jõesuu, River Rosona).

Cells 11—18 μm, closely surrounded by mucous coat 8 μm thick with numerous thin radial spicules arising from it.

9. *H.* cf. *myriopoda* Archer, 1869 (Fig. 4*A*, *B*)

Collected 02.09.1992 in the littoral clumps of *Hippuris vulgaris* in Lake Männijärv in the town of Elva (*2*).

Previously was recorded in Ireland (Archer, 1869), Germany (Greeff, 1875; Rainer, 1968), the Netherlands (Siemensma, 1981) and Sweden (Page and Siemensma, 1991).

Only one specimen was collected. Cell 27 μm, surrounded by mucous coat 10 μm thick, with radial spicules thicker but shorter than in the previous species (Fig. 4*B*) arising from it. Ectoplasm with many algal symbionts.

ORDER ROTOSPHAERIDA RAINER, 1968

Includes heliozoons without centroplast, axonemes and extrusomes. The cell coat contains various siliceous particles (scales, spicules or extraneous material).

Genus *Rabdiophrys* Rainer, 1968

10. *R. anulifera* Rainer, 1968 emend. Siemensma, 1981 (Fig. 4*C*, *D*)

Collected 02.09.1992 in the littoral clumps of *Hippuris vulgaris* in the Lake Männijärv in the town of Elva (*2*).

Previously recorded in Germany (Rainer, 1968), the Netherlands (Siemensma, 1981) and Canada (Nicholls, 1983b [as *Pinaciophora pinea*]). EM descriptions in Nicholls (1983b), Roijackers and Siemensma (1988).

Only two specimens were collected. Cells 25—27 μm, with two types of SpSc. lSpSc 5.6—5.9 μm; Sh 0.15—0.19 μm; BPl is circular, ca 0.6 μm, with 4 wing-like structures; the apex is flattened, ca 0.35 μm. sSpSc ca 2.6 μm long; Sh ca 0.20 μm; BPl ca 0.5 μm; apex ca 0.3 μm. There is a whole spectrum of spicules of intermediate size. PlSc are circular, 1.6—2.0 μm in diameter, with one central large pore 0.5—0.6 μm in diameter.

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TSENTROHELIIDSETEST JA ROTOSFERIIDSETEST PÄIKELOOMADEST (*HELIOZOA*) EESTIS VÕRTSJÄRVE LIMNOLOOGIAJAAMA ÜMBRUSES

On leitud 9 liiki tsentroheliide ja üks *Rotosphaerida* esindaja ning esitatud nende mikrofotod. 8 liiki on esmasleiud Eestist.

On kirjeldatud uus alamliik *Choanocystis perpusilla heterospina*, läbimõõduga 12—14 µm. Alamliiki iseloomustavad periplastis asuvad kahesugused nõeljad soomused, mille pikkus on suurem kui keha läbimõõt, ja tugevasti nõgusa keskosaga plaatjad soomused.

Кирилл МИКРЮКОВ

О ЦЕНТРОХЕЛИДНЫХ И РОТОСФЕРИДНЫХ СОЛНЕЧНИКАХ (*HELIOZOA*) ЭСТОНИИ В ОКРЕСТНОСТЯХ ВЫРТСЪЯРВСКОЙ ЛИМНОЛОГИЧЕСКОЙ СТАНЦИИ

Изучены 9 видов центрохелид и один представитель *Rotosphaerida* и приведены их микрофотографии, полученные на сканирующем электронном микроскопе. 8 видов отмечаются впервые для фауны Эстонии.

Описывается новый подвид *Choanocystis perpusilla heterospina* диаметром 12—14 мкм, который характеризуется присутствием в перипласте двух типов игольчатых чешуек (длинные превышают диаметр тела) и пластинчатыми чешуйками с сильно вогнутой центральной частью.