



New distributional records of eighteen species of *Vorticella* (Ciliophora: Peritricha) from mangrove ecosystem of Ayiramthengu in southwest coast of India

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Original Article

Abstract

The taxonomic characterization of twenty different species of *Vorticella* was made from prop roots and litters of intertidal area of Ayiramthengu mangrove ecosystem of Kerala, south west coast of India. Twenty Peritrich ciliates, viz., *Vorticella alba*, *V. annulata*, *V. bidulphae*, *V. companula*, *V. campanulate*, *V. communis*, *V. convallaria*, *V. chlorostigma*, *V. gracilis*, *V. jaerae*, *V. kenti*, *V. lima*, *V. longitricha*, *V. lymaeaurum*, *V. marina*, *V. marginata*, *V. microstoma*, *V. picta*, *V. similis*, and *V. subsinuata* were recorded. Their morphology and silver line system were described using live observation and silver impregnation. The study also revealed the fact that all the species except *V. companula* and *V. subsinuata* were found to be new records from India.

Keywords: Mangrove, ciliate, contractile vacuole, epibionts, *Vorticella*

Introduction

Peritrichs are the second most abundant oligohymenophorean group recorded under the phylum Ciliophora. Identification of peritrichs is very difficult because most of them possess a similar morphology, with overlapping characteristics. Misidentification and misinterpretation of characteristics of taxa have accumulated in the taxonomic literature over the years (Kahl, 1933; Song, 1986). The morphology of ciliates was determined using live observation and Silver impregnation. Silver impregnation is highly species specific, and this plays an essential role in determination of species (Clamp, 1990; Clamp and Bradbury, 1997; Foissner *et al.*, 1992; Ji and Song, 2004). Species in the genus *Vorticella* are well known as stalked, solitary peritrich ciliates with highly contractile behavior that have been found worldwide in marine and fresh water biotopes (Jankowski, 1976; Kahl, 1935; Precht, 1935; Song, 1991). Only a few works were carried out in India and most of them describe the peritrich to the genus level. The objective of this study is to identify and describe the *Vorticella* up to species level.

Material and methods

Samples were collected from the Ayiramthengu mangrove situated (lat. 9° 6' to 9° 8' N long. 76° 28' to 76° 29' E) in

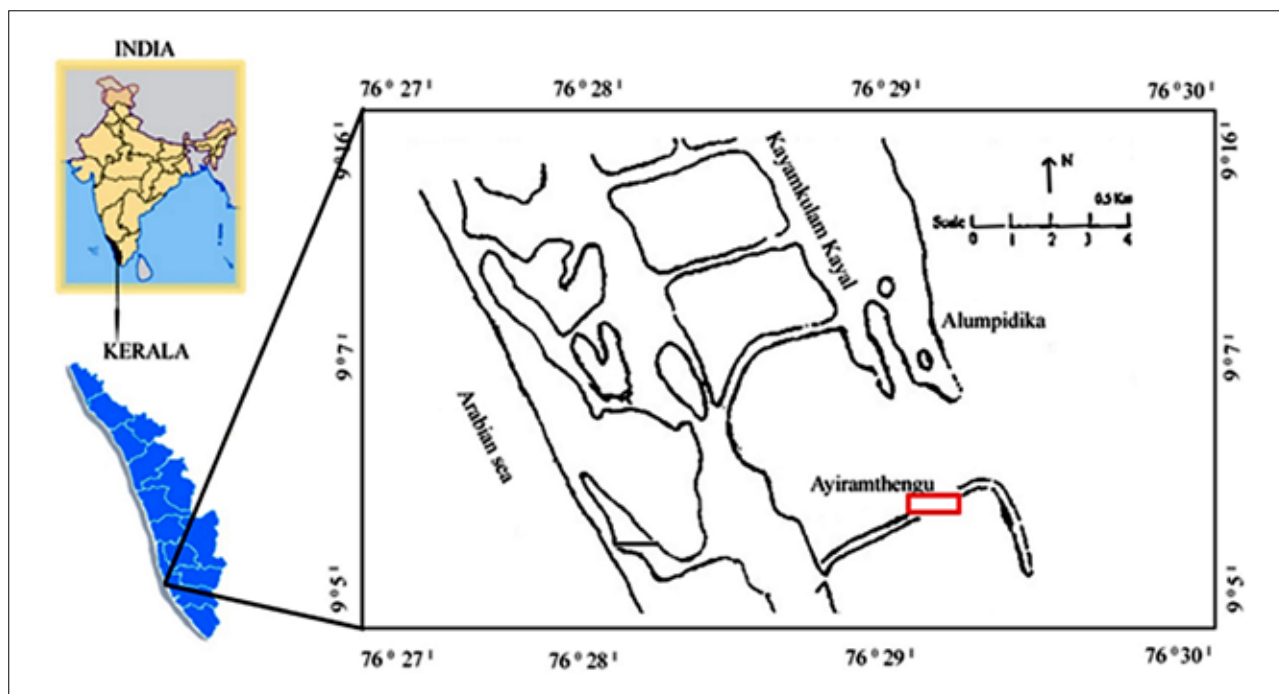


Fig. 1. Map showing the study area of Ayiramthengu mangrove ecosystem.

Kollam district of Kerala, a part of Kayamkulam estuary, which is the narrow stretch of tropical back water in the southwest coast of India (Fig. 1). Mangrove prop roots and litters were covered and attached by epibionts films and samples were taken by scraping 1 cm² patch of moist film into sterile 15 ml collecting tubes containing 3% formalin. Living ciliates were observed using bright field microscopy. For proper identification of epibionts, they were isolated and treated using the silver carbonate technique of Fernandez and Castro de (1986). The systematic scheme proposed by Lynn (2008) was followed.

Results and discussion

Twenty peritrich ciliates, *Vorticella alba*, *V. annulata*, *V. bidulphae*, *V. companula*, *V. campanulate*, *V. communis*, *V. convallaria*, *V. chlorostigma*, *V. gracilis*, *V. jaerae*, *V. kenti*, *V. lima*, *V. longitricha*, *V. lymaeorum*, *V. marina*, *V. marginata*, *V. microstoma*, *V. picta*, *V. similis*, and *V. subsinuata* were recorded from the study area (Fig. 2-3).

The taxonomic position of the genus *Vorticella* is given as follows:

Subkingdom	: Protozoa Goldfuss, 1818; Emend Von Siebold, 1845
Phylum	: Ciliophora Doflein, 1901
Class	: Oligohymenophora de Puytorac <i>et al.</i> , 1974
Subclass	: Peritrichia Stein, 1859
Order	: Peritrichida Stein, 1859
Sub order	: Sessilina Kahl, 1933

Family	: Vorticellidae Ehrenberg, 1838
Genus	: <i>Vorticella</i> Linnaeus, 1767

Vorticella alba Fromentel, 1874

Diagnosis: Zooid 55-70 µm long x 21 µm wide, inverted bell-shape and constricted below peristomial lip measures 23 µm; disc convex; contractile vacuole situated in upper 1/3 of zooid; infundibulum reaches 1/3 body length; macronucleus C-shaped; pellicle smooth and unstriated; stalk 150-250 µm long.

Vorticella annulata Gourret and Roeser, 1888

Diagnosis: Zooid 48-56 µm long x 35 µm wide, inverted bell-shape and constricted below peristomial lip measures 35 µm; large contractile vacuole present just below the peristome; infundibulum reaches 1/3 body length; zooids are filled with numerous zoo chlorella; stalk 110-180 µm long.

Vorticella bidulphae Stiller, 1939

Diagnosis: Zooid 35-44 µm long x 22 µm wide, triangular in shape with a broad peristomial lip measuring 38- 50 µm across; disc flat or slightly convex; infundibulum reach as the centre of the zooid; contractile vacuole situated in upper 1/3 of zooid; macronucleus C shaped; pellicle distinctly striated with convex ribbing between the striations; stalk 100-130 µm long.

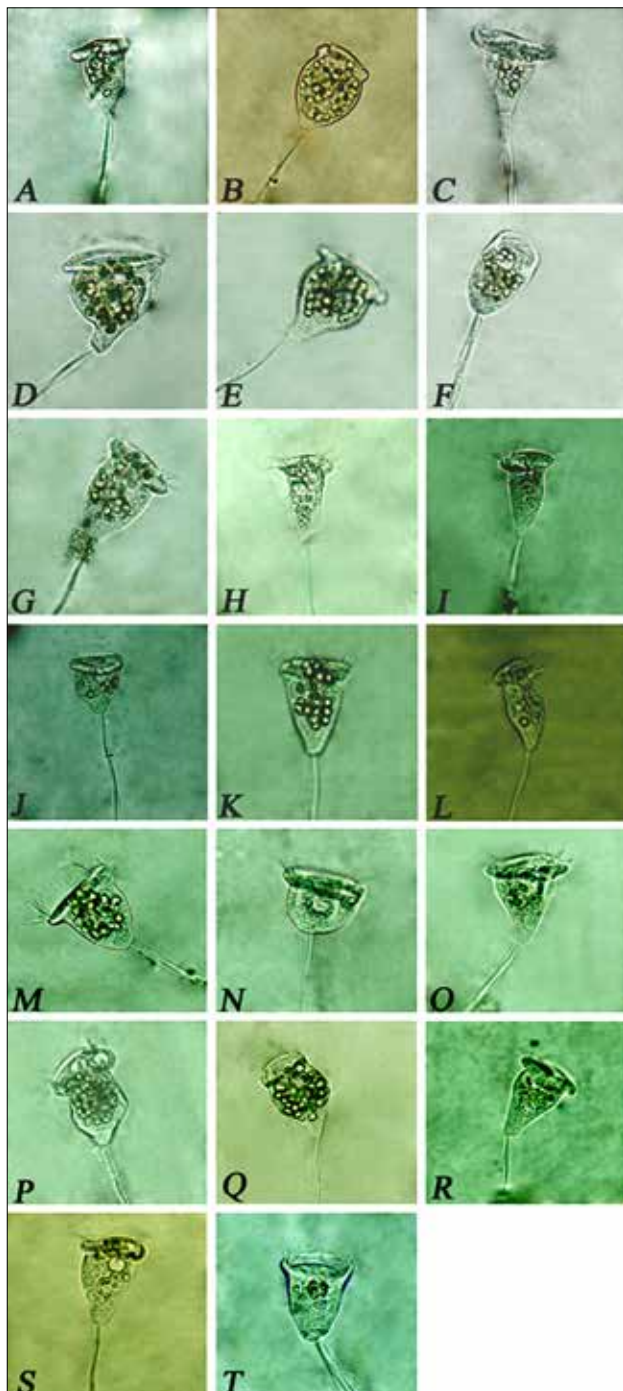


Fig. 2. A-T. Living morphology of species identified. A: *Vorticella alba* (Fromentel, 1874). B: *Vorticella annulata*. (Gourret and Roeser, 1888). C: *Vorticella bidulphae*. (Stiller, 1939). D: *Vorticella companula*. (Ehrenberg, 1831). E: *Vorticella campanulate*. (Kahl, 1933). F: *Vorticella communis*. (Fromentel, 1874). G: *Vorticella convallaria*. (Linnaeus, 1758). H: *Vorticella chlorostigma*. (Ehrenberg, 1831). I: *Vorticella gracilis*. (Dujardin, 1841). J: *Vorticella jaerae*. (Precht, 1935). K: *Vorticella kenti*. (Kahl, 1935). L: *Vorticella lima*. (Kahl, 1933). M: *Vorticella longitricha*. (Gajewskaja, 1933). N: *Vorticella lymaeorum*. (Viljoen and As, 1983). O: *Vorticella marina*. (Greeff, 1870). P: *Vorticella marginata*. (Stiller, 1931). Q: *Vorticella microstoma*. (Ehrenberg, 1830). R: *Vorticella picta*. (Ehrenberg, 1831). S: *Vorticella similis*. (Ehrenberg, 1830). T: *Vorticella subsinuata*. (Ghosh, 1922).

Vorticella companula Ehrenberg, 1831

Diagnosis: Zooid 60-155 μm long x 52 μm wide and constricted beneath peristomial lip which measures 65- 130 μm ; inverted bell shaped; contractile vacuole situated in upper 1/3 of zooid; macronucleus long, J- shaped and situated longitudinally; cytoplasm contain numerous dark, refractile granules; pellicle striated; stalk 180-510 μm long.

Vorticella campanulate Kahl, 1933

Diagnosis: Zooid 45-50 μm long x 53 μm wide constricted beneath peristomial lip which measures 50 μm across; disc flat; infundibulum reaches 1/3 body length; contractile vacuole situated just beneath the peristome; macronucleus C- shaped situated longitudinally in the zooid; pellicle striated; stalk 160-450 μm long.

Vorticella communis Fromentel, 1874

Diagnosis: Zooid 26-30 μm long x 24 μm wide, somewhat round and slightly constricted beneath the peristomial lip which measures 25 μm diameter disc flat; contractile vacuole situated in the upper 1/3 of the body; macronucleus C- shaped and lies at the center of the zooid; pellicular striation not visible ; stalk 200-300 μm long.

Vorticella convallaria Linnaeus, 1758

Diagnosis: Zooid 53-97 μm long x 34-53 μm wide; inverted bell- shaped and constricted beneath the peristomial lip which measures 53- 70 μm across; disc flat and slightly convex and obliquely elevated; infundibulum reaches 1/3 body length; Contractile vacuole situated in upper 1/3 of zooid; macro nucleus long and J-shaped; pellicle distinctly striated; stalk 400-450 μm long.

Vorticella chlorostigma Ehrenberg, 1831

Diagnosis: Zooid 58-65 μm long x 23-28 μm wide; almost conical in shape; sometimes with a distinct ridge near the telotroch band sharply constricted beneath the peristomial lip which measures 28-33 μm diameter ; disc flat and slightly elevated above peristome; infundibulum reaches 1/4 body length; contractile vacuole situated in upper 1/3 of zooid; macronucleus C- shaped situated longitudinally in the zooid; cytoplasm contain numerous endosymbiotic zoochlorellae; pellicle finely striated; stalk 580-650 μm long.

Vorticella gracilis Dujardin, 1841

Diagnosis: Zooid 52-76 μm long x 26-38 μm wide; elongated

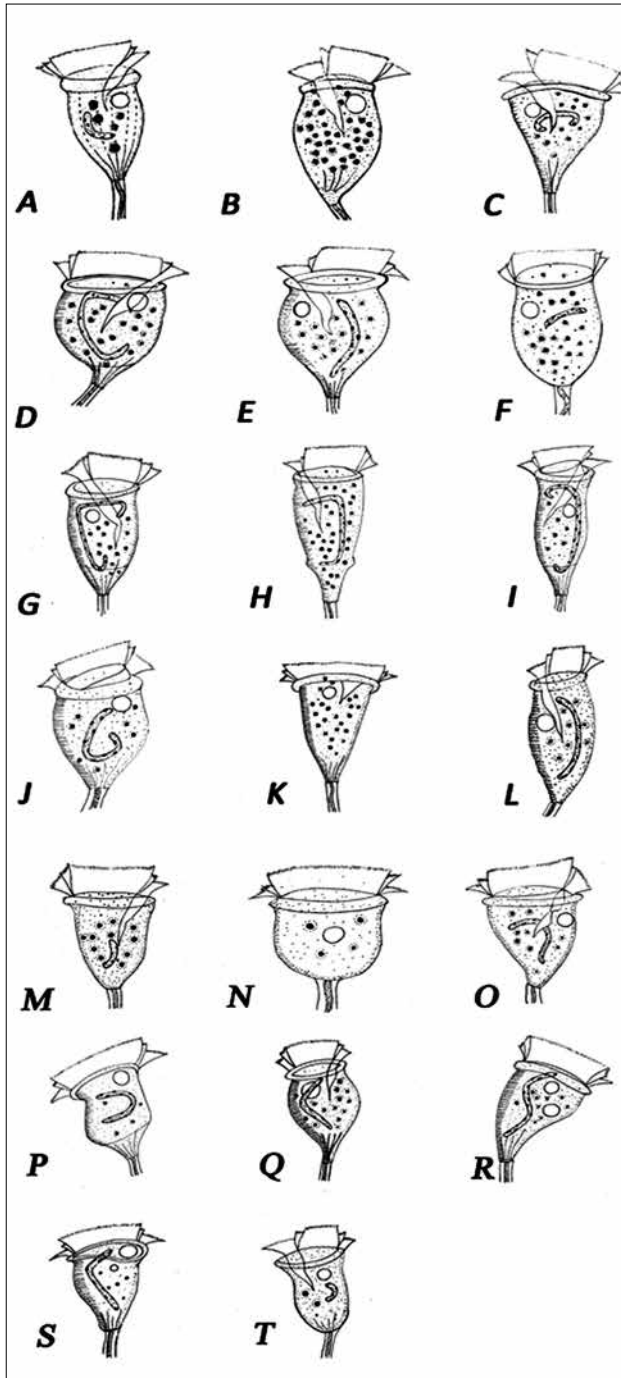


Fig. 3. A-T. Photomicrographs of species identified. A: *Vorticella alba* (Fromentel, 1874). B: *Vorticella annulata*. (Gourret and Roeser, 1888). C: *Vorticella bidulphae*. (Stiller, 1939). D: *Vorticella companula*. (Ehrenberg, 1831). E: *Vorticella campanulate*. (Kahl, 1933). F: *Vorticella communis*. (Fromentel, 1874). G: *Vorticella convallaria*. (Linnaeus, 1758). H: *Vorticella chlorostigma*. (Ehrenberg, 1831). I: *Vorticella gracilis*. (Dujardin, 1841). J: *Vorticella jaerae*. (Precht, 1935). K: *Vorticella kenti*. (Kahl, 1935). L: *Vorticella lima*. (Kahl, 1933). M: *Vorticella longitricha*. (Gajewskaja, 1933). N: *Vorticella lymaeorum*. (Viljoen and As, 1983). O: *Vorticella marina*. (Greeff, 1870). P: *Vorticella marginata*. (Stiller, 1931). Q: *Vorticella microstoma*. (Ehrenberg, 1830). R: *Vorticella picta*. (Ehrenberg, 1831). S: *Vorticella similis*. (Ehrenberg, 1830). T: *Vorticella subsinuata*. (Ghosh, 1922).

trumpet-shaped shape; slightly constricted beneath the peristomial lip which measures 37-44 μm diameter; disc convex; infundibulum broad and reaches centre of zooid; Contractile vacuole situated just beneath peristome; pellicle finely striated; stalk 280-320 μm long.

Vorticella jaerae Precht, 1935

Diagnosis: Zooid 40-57 μm long x 48-56 μm wide; inverted bell shaped constricted beneath the peristomial lip which measures 33-42 μm diameter; disc flat; contractile vacuole situated in upper 1/3 of zooid; irregularly shaped macronucleus; pellicle distinctly striated; stalk 100-140 μm long.

Vorticella kenti Kahl, 1935

Diagnosis: Zooid 135-160 μm long x 34-43 μm wide; elongated trumpet-shaped shape; not constricted beneath the peristomial lip which measures 90-110 μm diameter; disc flat; contractile vacuole situated just beneath peristome; pellicle finely striated; stalk 400-480 μm long.

Vorticella lima Kahl, 1933

Diagnosis: Zooid 55 -75 μm long x 28-32 μm wide; usually curved and constricted beneath well-developed peristomial lip which measures 24- 27 μm across; disc convex and elevated above peristome; infundibulum short; contractile vacuole situated in upper 1/3 of zooid; macronucleus C- shaped situated longitudinally in the zooid; pellicle distinctly striated with concave ribbing between the striations; stalk 145-180 μm long.

Vorticella longitricha Gajewskaja, 1933

Diagnosis: Zooid 29-34 μm long x 24-27 μm wide; inverted bell- shaped and no constricted beneath the peristomial lip which measures 30-37 μm across; disc prominently arched above peristome; infundibulum reaches 1/3 body length; contractile vacuole situated just below peristome ; macronucleus C- shaped situated longitudinally in the zooid; pellicle finely striated; stalk 80-100 μm long.

Vorticella lymaeorum Viljoen and As, 1983

Diagnosis: Zooid 25-32 μm long x 26-37 μm wide; inverted bell- shaped with a broad peristomial lip which measures 43-47 μm across; peristomial disc convex; macronucleus C- shaped; pellicle striated ; stalk 198-247 μm long.

Vorticella marina Greeff, 1870

Diagnosis: Zooid 35-67 μm long x 42-53 μm wide; inverted bell- shaped and sharply constricted below peristomial lip which

measures 38-53 μm ; disc flat and obliquely elevated above peristome; infundibulum short; contractile vacuole large and situated just below the peristome; macronucleus C- shaped; pellicle distinctly striated; stalk 290-310 μm long.

Vorticella marginata Stiller, 1931

Diagnosis: Zooid 65-100 μm long x 30-45 μm wide; elongate and slightly constricted beneath the peristomial lip which measures 90- 105 μm across; disc broad, flat and obliquely elevated above peristome; infundibulum short; macronucleus C- shaped; pellicle finely striated; stalk 230-250 μm long.

Vorticella microstoma Ehrenberg, 1830

Diagnosis: Zooid 29-88 μm long x 20-46 μm wide; inverted bell- shaped and constricted beneath the peristomial lip which measures 13- 23 μm across; disc convex and infundibulum reaches 1/3 body length; Contractile vacuole empties into ventral wall of infundibulum; cytoplasm contain numerous endosymbiotic zoochlorellae; macro nucleus long and C-shaped; pellicle distinctly striated; stalk 360-400 μm long.

Vorticella picta Ehrenberg, 1831

Diagnosis: Zooid 41-69 μm long x 25-40 μm wide; inverted bell- shaped and slightly constricted beneath peristomial lip which measures 36-56 μm across; disc convex; two contractile vacuole situated in upper 1/3 of zooid; macronucleus long, J- shaped and situated longitudinally; pellicle finely striated; stalk 520-600 μm long.

Vorticella similis Ehrenberg, 1830

Diagnosis: Zooid 56-83 μm long x 36-49 μm wide; elongate and slightly constricted beneath the peristomial lip which measures 41-45 μm across; disc convex ; contractile vacuole large and situated just below the peristome; pellicle finely striated; stalk 120-200 μm long.

Vorticella subsinuata Ghosh, 1922

Diagnosis: Zooid 43-55 μm long x 33-42 μm wide; inverted bell- shaped may or may not be constricted below peristomial lip which measures 38-48 μm infundibulum short. Contractile vacuole situated in upper 1/3 of zooid; macronucleus short; pellicle not striated; stalk 45-50 μm long.

Peritrichs are the most successful symbionts of the class Oligohymnophorea coming under the phylum Ciliophora. This is undoubtedly due in part to their ability to attach to a variety of substances and in genera sessiline peritrichs

use the scopula while mobiline forms use their adhesive disc for attachment (Lom, 1994). The scopula may secrete substances to aid attachment to the host surface or may have specialized cilia that enable attachment (Lom and Corlis, 1968). Regarding the occurrence of *Vorticella* species, Santhakumari and Balakrishnan (1985) isolated and described *V. companula* from wood-boring isopod *Sphaeroma* and Ghosh (1922) described *Vorticella subsinuata* as a new species from two different regions of India. The occurrence of twenty species of genus *Vorticella* during the present study is the first ever report from the Ayiranthengu mangrove ecosystem of Kerala, south west coast of India and out of the twenty species, except *V. companula* and *V. subsinuata*, the remaining 18 species are new distributional records from India.

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References

- Clamp, J. C. 1990. Redescription of three species of *Lagenophrys* (Ciliophora: Peritricha: Lagenophryidae) and a new North American species of *Lagenophrys* from hypogean amphipods. *Trans. Am. Microsc. Soc.*, 109: 1-31.
- Clamp, J. C. and P. C. Bradbury. 1997. Redescription of *Ellobiophrya brevipes* (Laird, 1959) n. comb.(Ciliophora, Peritrichia) and the fine structure of its pellicle and cinctum. *J. Eukaryot. Microbiol.*, 44(4): 374-382.
- Doflein, F. 1901. Die Protozoen als parasite und Krankheitserreger, nach biologischen Gesichts punkten dargestellt. *Fischer Verlag*, Jena, 274 pp.
- Dujardin, F. 1841. Understanding the physiology and classification of these animals and how to study them using the microscope. Natural history of zoophytes. *Infusoria Roret*. Paris, 678 pp.
- Ehrenberg, C. G. 1830. Beitrage zur Kenntnis der Organisation der Infusorien und ihrer Geographischen Verbreitung, besonders in Siberien. *Abhandlungen der Akademie der Wissenschaften der DDR*, year 1832: 1-88.
- Ehrenberg, C. G. 1831. Ober die Entwicklung und Lebensdauer der Infusionsthiere; nebst ferneren Beitrage zu einer Vergleichung ihrer Organischen Systeme. *Abhandlungen der Akademie der Wissenschaften der DDR*, year 1831: 1- 154.
- Ehrenberg, C. G. 1838. *Die Infusionsthiere als vollkommene Organismen. Ein Blick in das tieferorganische Leben der Natur*. Leopold Voss Verlag, Leipzig. pp. 1-xvii, 1-548.
- Fernandez-Leborans and Castro de Zaldumbide. 1986. The morphology of *Anophrys arenicola* sp. nov. (Ciliophora, Scuticociliatida). *J. Nat. Hist.*, 20.3:713-721.
- Foissner, W., H. Berger and F. Kohmann. 1992. Taxonomische und o'kologische Revision der Ciliaten des Saprobienindex-Band II: Peritrichida, Heterotrichida, Odontostomatida. *Bayerisches Landesamt für Umwelt*, 5(92): 1-502.
- Fromentel, E. de. 1874. Etudes sur les Microzoaires ou Infusoires proprement Dits, Comprenant de Nouvelles Recherches sur Leur Organisation, Leur Classification, et al Description des Especes Nouvelles. *Peu Connues*. 364 pp.
- Gajewskaja, N. 1933. Zur Oekologie, Morphologie und systematik der infusorien des baikalsees. *Zoologica, Stuttgart*, 32: 1-298.
- Ghosh, E. 1922. New species of Vorticella from Calcutta. *Bulletin of the Carmichael Medical College, Belgachia, Calcutta* 3: 8-18.
- Goldfuss, G. A. 1818. *Über die Entwicklungsstufen des Thieres*, Nuremberg, 18:21.
- Gourret, F. and P. Roeser. 1888. Les protozoaires de vieux port de Marseille. *Archives de Zoologie Experimental et Generale, Paris* (Series 2) 4: 443-534.
- Greiff, R. 1870. Untersuchungen über den Bau und die Naturgeschichte der Vorticellen. *Archiv. für Naturgeschichte*, 37: 353-384.
- Jankowski, A. W. 1976. A revision of the order Sessilida (Peritricha). In *Material and Public Meeting of Protozoology*. Kiev: 168-170p.
- Ji, D., W. Song and A. Warren. 2004. *Pseudovorticella paracratera* n. sp., a new marine peritrich ciliate (Ciliophora: Peritrichida) from north China. *Hydrobiologia*, 515: 45-97.
- Kahl, A. 1933. Ciliata libera et commensalia. In: Die Tierwelt der Nord- und Ostsee. (Eds. G. Grimpe and E. Wagler). *Lief. 2* (3): 29-146.
- Kahl, A. 1933. Ciliata libera et commensalia. In: G. Grimpe and E. Wagler Eds., *Die Tierwelt der Nord und Ostsee*, *Lief. 23* (Teil, II, c3): Leipzig, 147-183.

- Kahl, A. 1935. Urtiereoder Protozoa I: Wimpertiereoder Ciliata (Infusoria). 4. Peritricha und Chonotricha. *Die Tierwelt Deutschlands*, 30: 651-886.
- Linnaeus, C. 1767. *Systemae Naturae*. 12th edition. Salvii, Holmiae.
- Linnaeus, C. 1758. *Syst. Nat.*, 10th edition. Salvii, Holmiae
- Lom, J. 1994. Sousclasse des Peritrichia Stein, 1859. In P. de Puytorac (Ed.), *Traité de zoologie, infusoiresciliés* 2: 681-737.
- Lom, J. and J. O. Corliss. 1968. Observations on the ultrastructure of two species of the peritrich ciliate genus *Scyphidia* and on their mode of attachment of their host. *Microscopy Society of America*, 87: 493-509.
- Lynn, D. H. 2008. *The Ciliated Protozoa, characterization, classification, and guide to the literature*, 3rd edition, 1-605p.
- Precht, H. 1935. Epizoen der KielerBucht. *Nova. Acta. Leopoldina*, 3: 405-474.
- Puytorac, P. de, A. Batisse, J. Bohatier, J. O. Corliss, G. Deroux, P. Didier, J. Dragesco G. Fryd-Versavel, J. Grain, C. A. Groliere, R. Hovasse, F. Iftode, M. Laval, M. Roque, A. Savoie and M. Thffrau. 1974. Proposed classification of phylum ciliophora doflein, 1901 (meeting on systematics, clermont-ferrand). *C. R. Acad. Sci. Paris*, 278: 2799-2802.
- Santha Kumari, V. and N. N. Balakrishnan. 1985. Some ciliates from the marine wood-boring isopod *Sphaeroma*. *Indian J. Fish.*, 32(2): 215-223.
- Siebold. C. T. E. 1845. Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere. In *Lehrbuch der Vergleichenden Anatomie* (eds Siebold C. T. E. V., Stannius H.). Berlin, Germany: von Veit.
- Song, W. 1986. Descriptions of seven new species of peritrichs on *Penaeus orientalis* (Peritricha: Zoothamnidae, Epistylididae). *Acta. Zoo. Taxonomic. Asinica.*, 11: 225-235.
- Song, W. 1991. Contribution to the commensal ciliates on *Penaeus orientalis*.I. (Ciliophora, Peritrichida). *J. Ocean U. China*, 21: 119-128.
- Stein, F. V. 1859. *Der Organismus der Infusion sthierenacheigenen Forschungen in systematischer Reihen folgebearbeitet*. I: 206.
- Stiller, J. 1931. Die Peritrichen Infusorien von Tihany und Umgebung. *Arbeiten des Ungarischen Biologischen Forschungs Institutes*, 4: 171-205.
- Stiller, J. 1939. Die Peritrichen fauna der Nordsee Bei Helgoland. *Archiv. Fur. Protistenkunde*, 92: 413-452.
- Viljoen, S. and As, J. G. Van. 1983. A taxonomic study of sessile peritrichians with notes on their substrate preferences. *J. Limnol. Soc. South Africa*, 9(1): 33-42.