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New Species of *Odonaticola* Sarkar *et* Haldar, 1981 (Apicomplexa: Conoidasida) from Dragonflies (Insecta: Odonata) in West Bengal, India

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Summary. Descriptions of four new species of the genus *Odonaticola* Sarkar *et* Haldar, 1981 (Apicomplexa: Conoidasida) from dragonflies (Insecta: Odonata) in the family Libellulidae in West Bengal are presented. These include: *Odonaticola bradinopyga* sp. n. from *Bradinopyga geminata*; *O. aspinosa* sp. n. from *Crocothemis servilia servilia*; *O. abhoypura* sp. n. from *Pantala flavescens* and *O. amojya* sp. n. from *C. s. servilia*.

Key words: Apicomplexa, Conoidasida, Odonata, *Odonaticola abhoypura* sp. n., *O. amojya* sp. n., *O. aspinosa* sp. n., *O. bradinopyga* sp. n.

INTRODUCTION

Ever since Sarkar and Haldar (1981) established the genus *Odonaticola* (Apicomplexa: Conoidasida) from *Brachythemis contaminata* (Fabricius, 1793), it has been a fascinating object of research to protozoan taxonomists. The genus has a wide-ranging distribution. It has been reported from Japan, diverse localities in the Indian subcontinent and also has been observed in odonates of Thailand and Indonesia (personal observation D. P. Haldar). Amoji and Kori (1992) revised the genus and listed 13 species of *Odonaticola*. However, they missed the name of *O. pantalae* Prema *et* Janardanan, 1991 from *Pantala flavescens* (Fabricius, 1798). Prasadan and Janardanan (1994) added another species *O. neurothemisi*, and Haldar and Biswas (2002) described three more new species in the genus. Hoshide and Janovy (2002) published a SEM account of the nucleus of *O. polyhamatus*. The study of gregarines from odonates assumes further importance since the hosts are highly beneficial and wonderful predators for many known and unknown insect pests.

Keeping this in mind we continued our study on the gregarine parasites of odonates and have discovered four more new species which have been described in this communication.

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The species of gregarines placed in *Odonaticola* differ principally in: (1) the number of petaloid spines on the epimerite; (2) length of the neck; (3) measurements and ratios of the body parts; (4) host species; and (5) geographical distribution. In all cases the body of the host is enormously long and a heavy load of parasites is present in the gut of infected animals. It may be extremely difficult for the hosts to fly easily and thus they may fall prey to a diversity of predators. Because ecologically the odonates are powerful determining factors in preserving the balance of life in ponds, rivers, lakes and their surroundings (Tillyard 1917), any decrease in their numbers may prove to be detrimental. It is, therefore, time to think about their gradual decline in numbers and to carry out research on appropriate natural conservation methods so that these beautiful creatures do not disappear altogether.

MATERIALS AND METHODS

Odonates do not survive in captivity, hence the digestive tracts were examined immediately after they were collected from the fields of Kalyani, Chandannagar, Abhoypur and Karimpur in the districts of Nadia and Hooghly (23-25°N and 88-89°E). Rest of the employed methods have been followed after Haldar and Biswas (2002) as elaborated hereunder.

Dragonflies were decapitated and then dissected under a dissecting Olympus No. 1116 binocular. The entire gut was carefully taken out and placed on a glass slide with a little drop of 0.5% saline solution. The gut was gently teased with needles for the parasites to come out of the gut lumen. The presence of parasites within the gut was observed by an Olympus CH2 phase contrast microscope in living condition. Thin smears were prepared on glass slides and the slides containing gregarines were fixed in Schaudinn's fluid for 20 min. Fixed slides were kept in 70% alcohol overnight to remove the excess mercuric chloride. Slides were then mordanted overnight in 3% iron alum and stained with Heidenhain's haematoxylin for 20 min. Differentiation of staining was done with 1% iron alum and slides were then thoroughly washed under running tap water, dehydrated in ascending grades of alcohol, cleared in xylene and mounted in DPX.

Gametocyst were collected from faecal matter or hindgut of infected hosts. For observing sporulation, the technique of Sprague (1941) with slight modifications has been followed.

For normal development of eugregarine cysts, highly successful results were obtained by incubating them at room temperature in moist chambers constructed in the following manner.

Two pieces of blotting papers were placed on both inner surfaces of the chamber and cysts were placed in a drop of normal saline (0.5%) on a glass slide and kept within moist chambers for at least 24 h. Cysts were observed from time to time under the microscope; mode of dehiscence of cysts was observed in this condition. Cysts ruptured to release innumerable oocysts with or without filaments; liberated oocysts were removed from the moist chamber at regular intervals and stages of development of sporozoites were also noted. A drop of oocyst suspension was taken on a glass slide and a drop of Lugol's iodine solution was added to it; developmental stages of sporozoites were observed under oil immersion lens. Figures of stained specimens were drawn with the aid of a camera lucida using a YOMA microscope, measurements were taken using an ocular micrometer calibrated with a stage micrometer.

The following abbreviations are used: DG - diameter of gametocyst; LD - length of deutomerite; LE - length of epimerite; LEN - length of epimerite neck; LN - length of nucleus; LO - length of oocyst; LP - length of protomerite; TL - total length; WD - width of deutomerite; WE - width of epimerite; WN - width of nucleus; WO - width of oocyst; WP - width of protomerite. The ratios used are the ratio of the length of protomerite to total length (LP: TL) and the ratio of the width of protomerite to the width of deutomerite (WP: WD).

Primary types are deposited in the following collections: PLUK-Protozoology Laboratory, University of Kalyani, West Bengal, India; HWML - Harold W. Manter Laboratory of Parasitology, University of Nebraska, Lincoln, Nebraska, USA.

RESULTS

Odonaticola Sarkar *et* Haldar, 1981

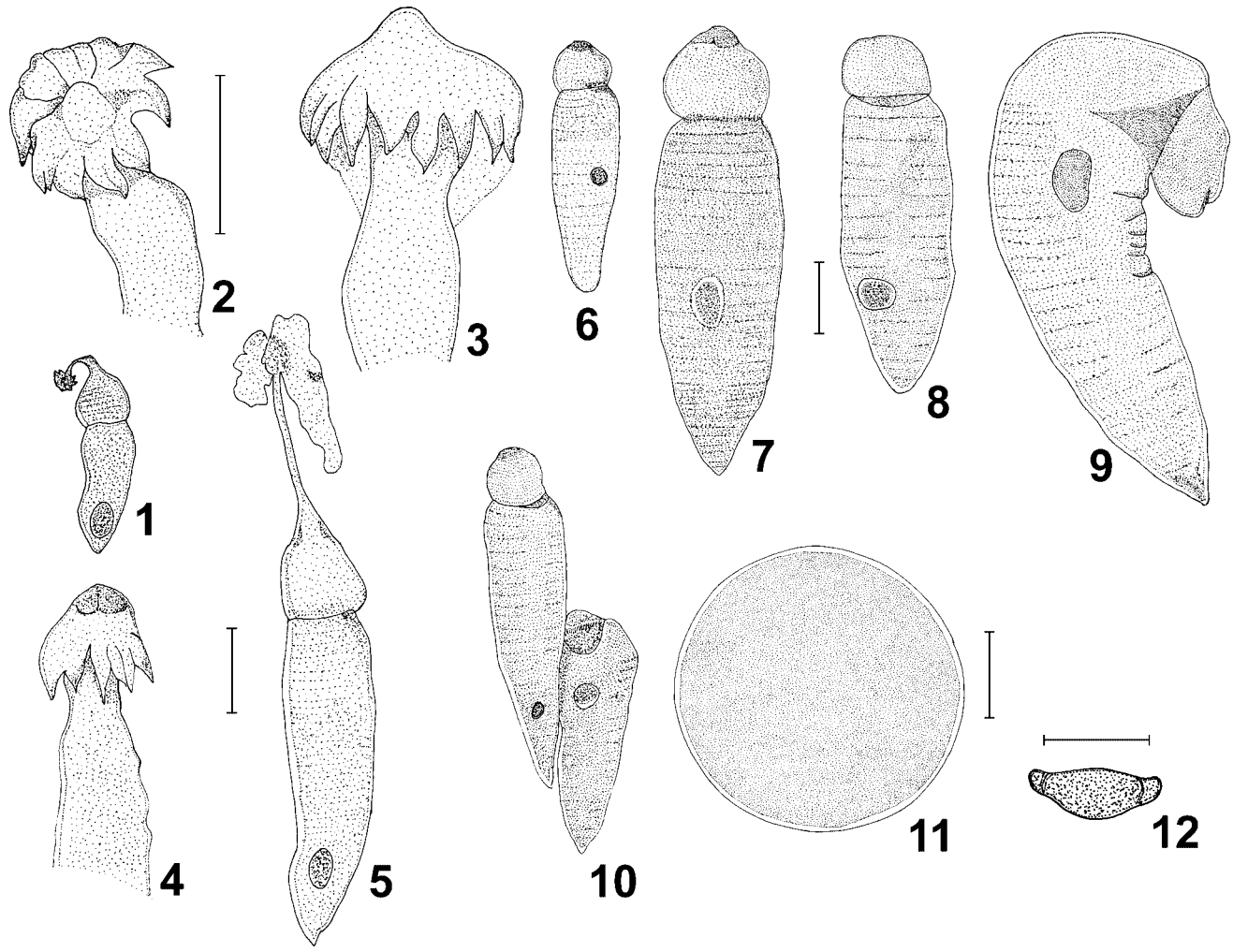
Diagnosis: The gregarines parasitizing odonates are very large and are placed in the genus *Odonaticola* (Actinocephalidae: Menosporinae) based on the following diagnostic features: epimerite hat-shaped; marginal spines petaloid; neck long; sporadins solitary; gametocysts dehisce by simple rupture; and, oocysts smooth, boat-shaped.

Type species: *Odonaticola hexacantha* Sarkar *et* Haldar, 1981; by original designation.

Remarks: The septate gregarines (Apicomplexa: Conoidasida) are endoparasitic protozoans commonly found in the digestive tracts of various terrestrial arthropod hosts. Previously it was believed that flying insects such as dragonflies (Order Odonata) were less heavily parasitized by protozoan parasites, particularly by eugregarines, than other ground dwelling terrestrial insects. However observations made during the past few years have revealed the presence of a number of eugregarine protozoan parasites in their midgut (Haldar 1992).

Odonaticola bradinopyga sp. n. (Figs 1-12)

Trophozoite: Epimerite consisting with long slender neck and hat- or umbrella-shaped knob at apex; edge of knob drawn into 10-12 petaloid lobes, each lobe gradually tapered to sharp tip and marked with central longitudinal line; protomerite conical; deutomerite cylindro-conical or fusiform; cytoplasm densely granulated and



Figs 1-12. *Odonaticola bradinopyga* sp. n. trophozoites: **1** - entire view; **2**, **3** - epimerite fronto-lateral view; **4** - epimerite lateral view; **5** - epimerite attached to gut tissue of host sporadins: **6** - early stage; **7-9** - various shapes, sizes and positions; **10** - sidewise association. **11** - gametocyst, advanced stage; **12** - oocyst. Scale bars 10 µm (12); 20 µm (2, 3); 100 µm (1, 4-10); 200 µm (11).

lodges an ovoidal nucleus; nucleus position variable from mid body to periphery.

Sporadin: Characteristically solitary; protomerite more or less bell-shaped; deutomerite cylindro-conical in shape; cytoplasm densely granulated and with numerous transverse striations of myoneme fibrils; body highly flexible.

Association: Sidewise between two morphologically variable sporadins.

Gametocyst: Colour milky white, covered by thin ectocyst. After 88 h, ectocyst detaches from cyst wall followed by noticeable appearance of some notches on its surface; after 96 h cyst wall bursts by simple rupture and oocysts liberated.

Oocyst: Boat-shaped when single; triangular-shaped when in clusters of three.

Measurements (in µm) (n = 20):

Trophozoite: TL = 333-1029 (595); LE = 36-246 (134.9); WE = 14-72(31.7); LP = 58-130(83.3); WP = 65-196 (113.2); LD = 188-681(376.7); WD = 58-188(124.1); LEN = 58-217 (128.3); WN = 22-51(35.3); LN = 36-72 (48.9)

Sporadin: TL = 222-1405 (666.9); LP = 71-174 (113.4); WP = 75-188 (131.9); LD = 151-1261 (553.5); WD = 75-232 (158.4); LN = 27-72 (52.9); WN = 18-58 (40.1); DG = 656-670; LO = 12-13; WO = 6; LP: TL = 1: 3.8-9.4; WP: WD = 1: 0.8-2.1

Taxonomic summary

Type material: Catalog No.: 1-14. 13 slides containing syntypes have been deposited at the PLUK; 1 slide containing hapantotype has been deposited at the HWML, Lincoln, Nebraska, U.S.A; Catalog No.: HWML 45347

Type locality: India, West Bengal, Kalyani in Nadia district, Kalyani University campus.

Host: Dragonfly *Bradinopyga geminata* (Rambur, 1842) (Insecta: Odonata: Anisoptera: Libellulidae)

Location in host: Midgut.

Incidence of infection: Of 100 odonate hosts examined 44 (44.5%) were found to be infected.

Etymology: The specific epithet is derived from the genus of host from which the gregarine was collected.

Remarks: For the first time in India, *Bradinopyga geminata* (Rambur, 1842) has been recorded to host a species of the genus *Odonaticola*. In *Odonaticola bradinopyga* the epimerite consists of a long slender neck with a spherical hat-shaped structure at its apex. The tip looks like an umbrella, in which the edge is drawn out into 10-12 petaloid lobes that are at the tips and marked with a central longitudinal line. Other species described by Sarkar and Haldar (1981) with a hat-shaped epimerite are characterized by variable number of petaloid spines, namely: *O. hexacantha*, the type species of the genus has 6; *O. longicollara* has 7; *O. rodgii* has 8; and *O. orthetri* has several petaloid spines. Six petaloid spines also are present in *O. neurothemisi* Prasadan and Janardanan, 1994 although it differs from the type species in other features. Oocysts are boat-shaped in all the previously described species along with two short projections on the sides in *O. hexacantha* and triangular when in clusters of three in the present species. The sporadins are long enough in *O. longicollara* and *O. rodgii* and resemble the newly described species. In addition, the hosts and the collection localities are also different in all the species. Hence we consider this gregarine to represent a new species.

***Odonaticola aspinosa* sp. n. (Figs 13-22)**

Trophozoite: Epimerite blunt umbrella-like with long slender neck; characteristic petaloid spines absent; protomerite hemispherical; deutomerite almost spherical; nucleus large spherical with distinct endosome.

Sporadin: Solitary; protomerite cylindrical in smaller forms; deutomerite almost spherical with rounded nucleus. Association: biassociative forms rarely found; two associating partners differ greatly in morphology. Gametocyst: large, milky white spherical bodies; two unequal gametocytes covered by thin uneven ectocyst; oocysts liberate by simple rupture after 48 h.

Oocyst: Boat shaped.

Measurements (in µm) (n= 20):

Trophozoite: TL = 291-728 (441.7); LE = 93-198 (133.7); WE = 7-52 (24.4); LP = 43-156 (93.6); WP = 57-125 (75.8); LD = 114-374 (214.5); WD = 100-218 (161.2); LN = 16-88 (40.2); WN = 21-43 (33.6)

Sporadin: TL = 191-426 (255.7); LP = 70-100 (76.0); WP = 41-80 (54.6); LD = 92-348 (173.8); WD = 101-165 (189.1); LN = 21-64 (41.5); WN = 21-50 (36.4); DG = 329; LO = 6; WO = 4; LP: TL = 1: 1.9-8.0 (3.7); WP: WD = 1: 1.6-2.7 (2.2)

Taxonomic summary

Type material: Catalog No.: 1-14. 13 slides containing syntypes have been deposited at the PLUK; 1 slide containing hapantotypes has been deposited at the HWML, Lincoln, Nebraska, U.S.A; Catalog No.: HWML 16519

Type locality: India, West Bengal, Hooghly district, Chandannagar.

Host: Dragonfly *Crocothemis servilia servilia* (Drury, 1773) (Insecta: Odonata: Anisoptera: Libellulidae)

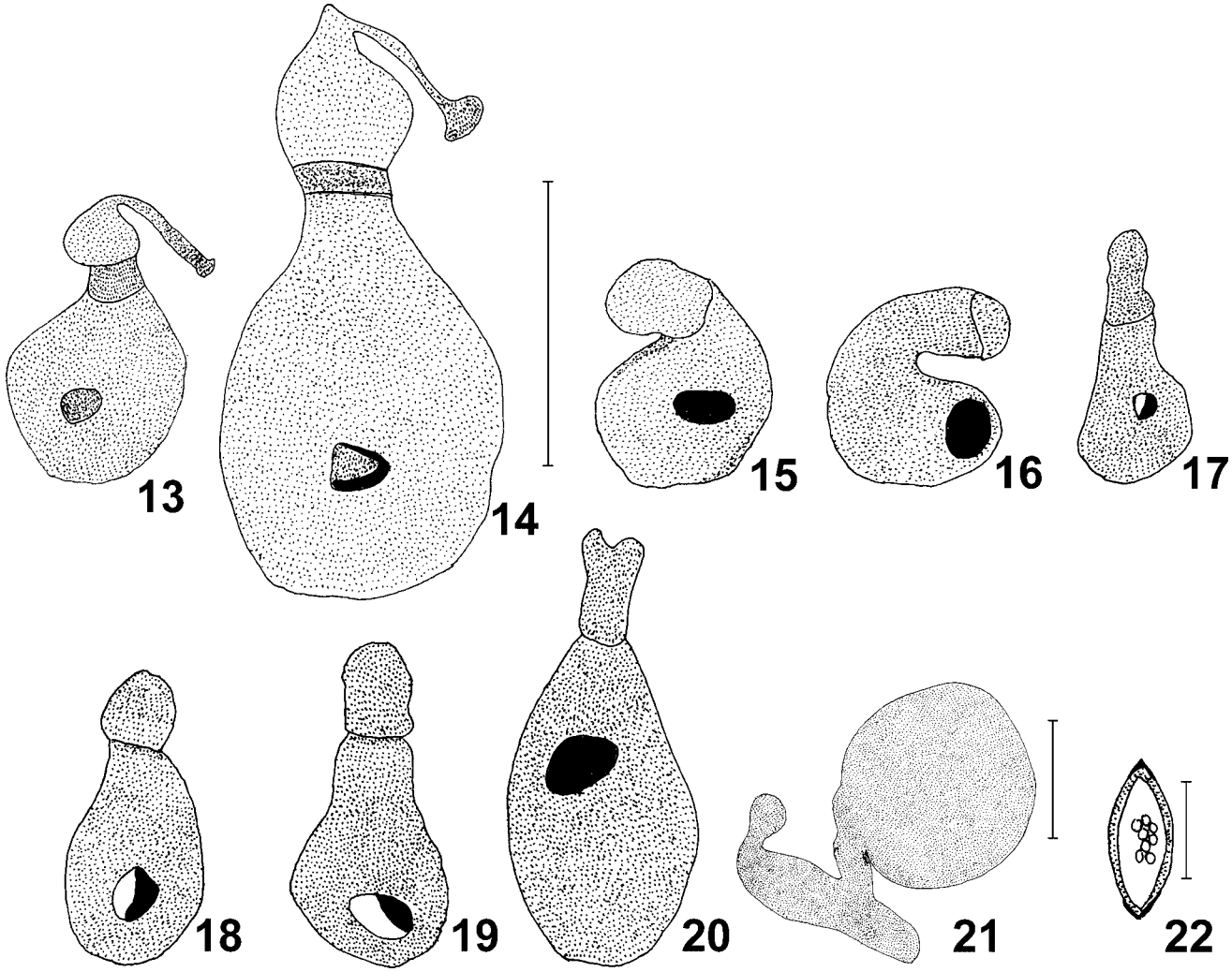
Location in host: Midgut.

Incidence of infection: Of 958 dragonfly hosts examined 33 (3.4 %) were found to be infected.

Etymology: Due to the absence of characteristic petaloid spines, the name *aspinosa* has been proposed for it.

Remarks: Based on having solitary sporadins, umbrella-like epimerite with long slender neck, simple rupture of gametocysts and boat-shaped oocysts, the present species justifies being placed in the genus *Odonaticola*.

The newly described species resembles *Odonaticola crocothemis* Kori *et* Amoji, 1983 in maximum length of trophozoite and shape of oocysts but can be separated based on differences in the shape of the epimerite, gametocyst and statistical measurements. In both cases the host insect is *Crocothemis servilia servilia* (Drury). The presently described species resembles *O. magnus* (Hoshide, 1958) (= *Hoplorhynchus magnus*) nov. comb. in having an umbrella-like epimerite, boat-shaped oocysts which vary in dimensions but is dissimilar in shape and length of sporadin, diameter of gametocyst and other morphometric values. The average length of trophozoites in *O. elliptica* Sarkar, 1981 and the newly described form are nearly identical besides other similarities like spherical shape of gametocyst with thin cyst wall and boat-shaped oocysts; both also infect the same host.



Figs 13-22. *Odonaticola aspinosa* sp. n. **13** - young trophozoite; **14** - mature trophozoite; **15-17** - early stage sporadin; **18-20** - mature sporadin; **21** - gametocyst dehiscing by simple rupture; **22** - oocysts with eight sporozoites. Scale bars 10 µm (22); 200 µm (13, 14); 200 µm (15-21).

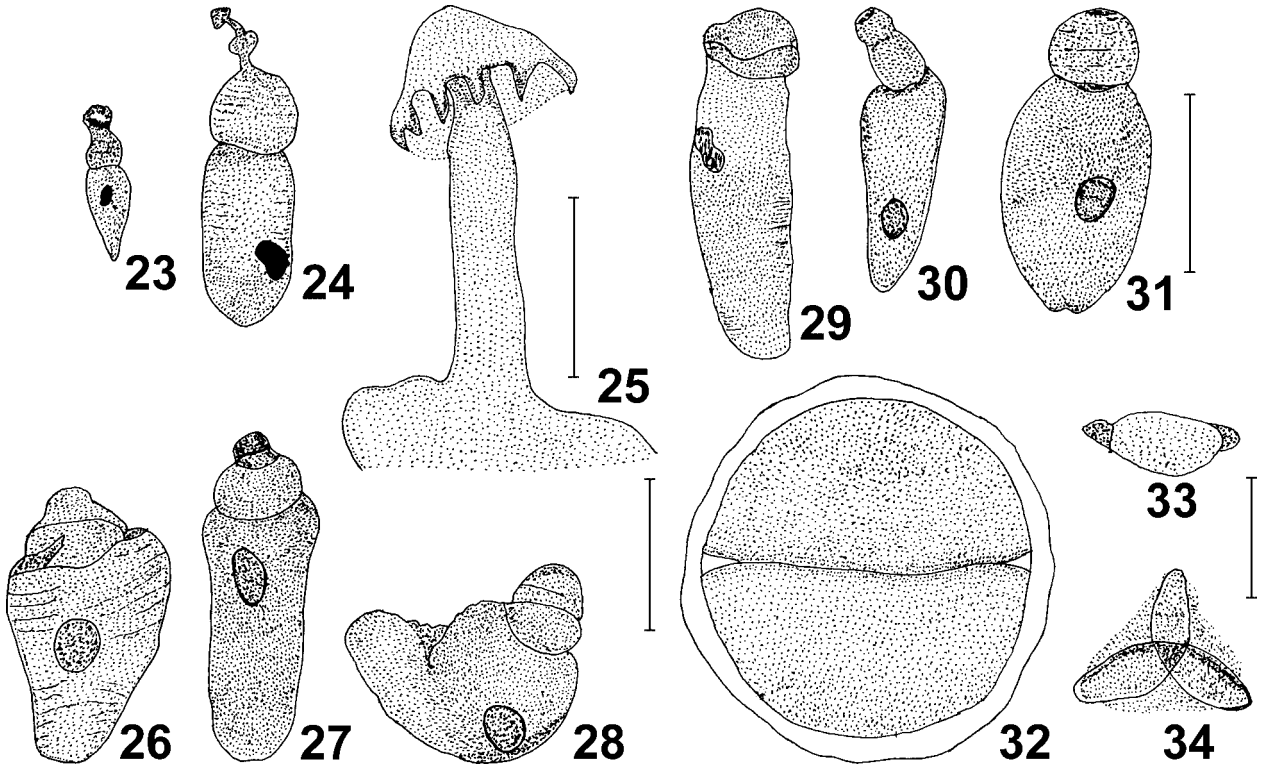
However the two species differ in the structure of epimerite which is knob-like with 10 petaloid recurved spines at its periphery with a long neck, a bell- or dome-shaped protomerite and a long slender deutomerite in *O. elliptica* and the epimerite is umbrella-like with a long slender neck, devoid of any petaloid spines in the present form, a feature that at once distinguishes it from *O. elliptica*; the shape and size of the protomerite and deutomerite are also different in the two species.

Based on differences in a number of features with other species inhabiting the same host, we designate *Odonaticola aspinosa* as a new species.

***Odonaticola abhoypura* sp. n. (Figs 23-34)**

Trophozoite: Epimerite bud-like with short neck; drawn into 7-11 petaloid recurved spines placed at noticeable distances from each other; protomerite globular; deutomerite cylindro-conical; epimerite in fully grown trophozoites with a swollen bulbous portion at the middle of neck; nucleus ovoid or slightly crescentic; cytoplasm densely granular with crosswise striations.

Sporadin: Solitary; protomerite globular, conical, rectangular or cylindrical; deutomerite ellipsoid, tubular or cylindro-conical; nucleus ovoid, ellipsoid or bilobed, posi-



Figs 23-34. *Odonaticola abhoypura* sp. n. **23** - young trophozoite; **24** - mature trophozoite; **25** - epimerite, lateral view; **26-29** - early sporadin; **30, 31** - mature sporadin; **32** - early gametocyst; **33** - single oocyst; **34** - cluster of oocysts. Scale bars 10 µm (33, 34); 20 µm (23-25); 200 µm (26-32).

tion variable; larger cytoplasmic granules and crosswise myonemmal striations present.

Association: Biassociative forms rarely found; partners differ greatly in shape and size.

Gametocyst: Rounded or slightly ovoid; double-walled enclosing two unequal gametocytes; dehisces by simple rupture at 72 h.

Oocyst: Boat-shaped when liberated singly, triangular-shaped when in clusters of three.

Measurements (in µm) (n=20):

Trophozoite: TL = 200-404 (336.7); LE = 40-120 (64.4); WE = 15-71 (39.6); LP = 29-89 (51.4); WP = 44-111 (85.5); LD = 131-280 (220.9); WD = 58-138 (108.4); LN = 33-53 (45.3); WN = 18-35 (26.6); LEN = 15-98 (61.4)

Sporadin: TL = 200-1492 (510.6); LP = 49-188 (92.7); WP = 67-362 (130.7); LD = 151-1318.0 (417.9); WD = 71-536 (200.0); LN = 35-130 (58.1); WN = 20-87 (37.4); DG = 524 x 508; LO = 13; WO = 6; LP: TL = 1: 2.7-10.5; WP: WD = 1: 0.5-3.0

Taxonomic summary

Type material: Catalog No.: 1-14. 13 slides containing syntypes have been deposited at the PLUK; 1 slide containing hapantotypes has been deposited at the HWML, Lincoln, Nebraska, U.S.A; Catalog No.: HWML 45351

Host: *Pantala flavescens* (Fabricius, 1798) (Insecta: Odonata: Anisoptera: Libellulidae)

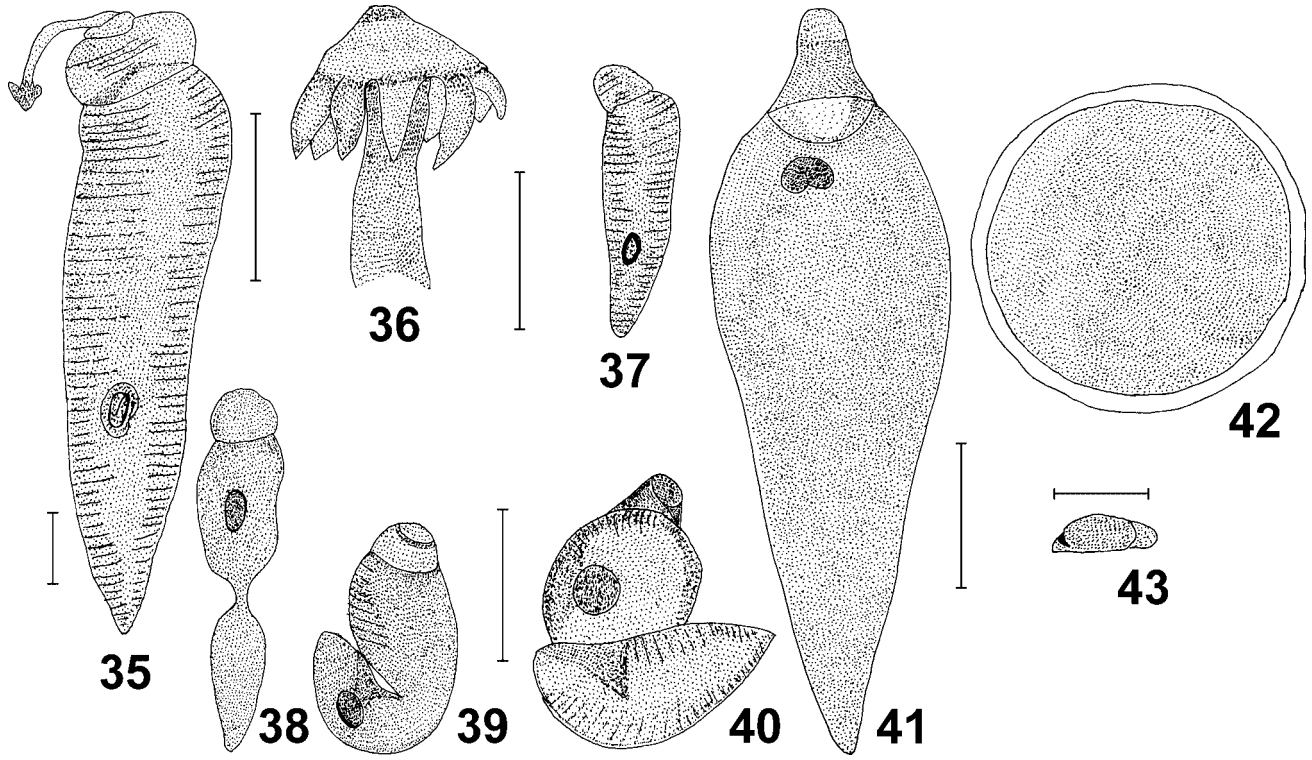
Type locality: India, West Bengal, Nadia district, Abhoypur (Karimpur)

Location in host: Midgut.

Incidence of infection: Of 55 dragonfly hosts examined 15 (25.4 %) were infected.

Etymology: The species is named after the locality where the host dragonflies were obtained.

Remarks: In 1991, Prema and Janardanan reported a new species *Odonaticola pantalae* from the dragonfly *Pantala flavescens* (Fabricius, 1798) in Kerala. Interestingly the gregarine under report obtained from



Figs 35-43. *Odonaticola amojya* sp. n. **35** - mature trophozoite; **36** - epimerite details; **37, 38** - sporadins different shapes and sizes; **39, 40** - bending position; **41** - mature sporadin; **42** - gametocyst, freshly formed; **43** - oocyst. Scale bars 10 µm (43); 20 µm (36); 100 µm (37, 38); 200 µm (35, 39-42).

the same host about 2000 km apart from Kerala shares all the basic characters with *O. pantalae*, for which its inclusion under the genus *Odonaticola* is beyond doubt. The epimerite is hat-shaped with 7-11 petaloid spines and a long slender neck in the gregarine under report. The size of the trophozoite and sporadin is much smaller in our new species. In *O. pantalae* the spherical gametocyst is provided with a thick ectocyst and its oocysts are boat-shaped having two short projections at each pole, while in the present form, gametocysts are either round or ovoid and oocysts do not bear any spines. Thus we designate this gregarine as a new species of the genus *Odonaticola* for which the name *O. abhoypura* sp. n is proposed.

***Odonaticola amojya* sp. n. (Figs 35-43)**

Trophozoite: Epimerite with long slender straight or bent neck and conical umbrella- or hat-shaped triangular knob at apex; edge drawn into 10 petaloid recurved spines at periphery by which parasites seem to stick to gut epithelium of host; protomerite more or less dome-shaped; deutomerite long fusiform; cytoplasm granular; nucleus ovoid at variable positions; transverse myoneme fibrils clearly discernable; pellicle highly flexible.

Sporadin: Solitary; slender when young bearing scars of just-detached epimerite at top; short rudimentary epimerite retained in a few sporadins; protomerite bell- or dome-shaped; deutomerite long slender; densely granular, traversed by transverse myonemmal lines; position of nucleus variable; very large sporadins bearing short slender nipple-like protomerite attached with gigantic posteriorly tapering deutomerite characteristically observed. Association: rarely biassociative; partners differ greatly in shape and size. Gametocyst: creamy white; globular, covered by transparent ectocyst; dehisce by simple rupture at 72 h.

Oocyst: Appear boat-shaped when in clusters of three; with eight sporozoites.

Measurements (in µm) (n=20)

Trophozoite: TL = 497-927 (758.3); LE = 71-232 (159.0); WE = 13-22 (17.8); LP = 80-116 (92.2); WP = 130-160 (139.4); LD = 311-638 (507.0); WD = 145-181 (163.8); LN = 65-72 (69.1); WN = 43-51 (48.4); LEN = 55-181 (133.4)

Table 1. Comparative characters of the four species that have been described here under the genus *Odonaticola* (measurements in µm).

Character	*O. bradinopyga* sp. n.	*O. aspinosa* sp. n.	*O. abhoypura* sp. n.	*O. amojya* sp. n.
Trophozoite	595	441	337	758
Epimerite	umbrella-like; edge drawn into 10-12 petaloid spines	umbrella-like with blunt edge	bud-like, circular; edge drawn into 7-11 petaloid spines	conical umbrella-like; edge drawn into 10 petaloid spines
Sporadin	667	442	511	874
	Protomerite bell-shaped; deutomerite cylindro-conical	Protomerite cylindrical; deutomerite almost spherical	Protomerite lobular, rectangular, cylindrical or conical; deutomerite ellipsoidal, tubular or cylindro-conical	Protomerite dome-shaped, slender or nipple-like; deutomerite slender and gigantic
Gametocyst	663	328	524 × 508	1008
	Milky-white; covered by thin ectocyst; dehisce by simple rupture	Milky-white; covered by thin ectocyst; dehisce by simple rupture	Milky-white; slightly ovoidal in outline; double-walled; dehisce by simple rupture	Creamy-white; covered by thin ectocyst; dehisce by simple rupture
Oocyst	12 × 6	10 × 4	13 × 6	12 × 4
	Boat-shaped when single; triangular when in clusters of three	Boat-shaped when single; triangular when in clusters of three	Boat-shaped when single; triangular when in clusters of three	Boat-shaped when single; triangular when in clusters of three
LP: TL (Trophozoites)	1:7	1: 4	1: 6.6	1: 8.2
WP: WD (Trophozoites)	1:1	1: 2	1:1	1:1
Host	*Bradinopyga geminata*	*Crocothemis s. servilia*	*Pantala flavescens*	*Crocothemis s. servilia*

Sporadin: TL = 493-2000 (873.5); LP = 87-246 (134.5); WP = 58-290 (137.6); LD = 391-1753 (739.0); WD = 101-580 (193.8); LN = 43-116 (68.8); WN = 36-72 (48.9); DG = 901-1116; LO = 12-13; WO = 4; LP: TL = 1:3.5-10.0; WP: WD = 1: 0.7-3.3

Taxonomic summary

Type material: Catalog No.: 1-14. 13 slides containing syntypes have been deposited at the PLUK; 1 slide containing hapantotypes has been deposited at the HWML, Lincoln, Nebraska, U.S.A; Catalog No.: HWML 45349

Type locality: India, West Bengal, Nadia district, Karimpur

Host: Dragonfly *Crocothemis servilia servilia* (Drury, 1773) (Insecta: Odonata: Anisoptera: Libellulidae)

Location in host: Midgut.

Incidence of infection: Of 89 dragonfly hosts examined 25 (28.1 %) were infected.

Etymology: The species is named in honour of the eminent odonatologist Prof. S. D. Amoji of Karnatak University, India

Remarks: In the literature three species of *Odonaticola* are reported from the common dragonfly *Crocothemis servilia servilia* (Drury). *Odonaticola amojya* sp. n differs from the others harboured by the same host in having a conical epimerite with 10 petaloid recurved spines and a long neck. In *O. magnus* the epimerite is umbrella-shaped with 6-7 recurved hooks and a long neck; *O. elliptica* has a conical umbrella-like epimerite with many curved spines and a neck elliptical in outline; and *O. crocothemis* has a hood-shaped epimerite with several downwardly directed laminated filaments with a central spine and a long neck. In addition *O. amojya* has a globular gametocyst with transparent ectocyst and boat-shaped oocysts. Although *O. magnus, O. crocothemis O. elliptica* and *O. amojya* share a common host, the structural and morphometric variations as well as different localities of collection of the host insect justify the designation of a new species.

The comparative characters of *Odonaticola* new species described from the dragonfly *C. s. servilia* have been compiled in Table 1.

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REFERENCES

Amoji S. D., Kori S. S. (1992) Revision of the genus *Odonaticola* Sarkar *et* Haldar, 1981(Apicomplexa: Gregarinasina). *Acta Protozool*. **31:** 169-171

Haldar D. P. (1992) Some aspects of protozoan parasites in odonates of India. Proc. IV South Asian Symposium on Odonatology, Allahabad, India. Abstracts: 1

Haldar D. P., Biswas S. (2002) On the structure and life history of three new species of the septate gregarines (Apicomplexa: Conoidasida) from odonates of West Bengal. In: Current Trends in Odonatology. (Ed. A. Kumar) Daya Publishing House, Delhi. 357-377

Hoshide H. (1958) Studies on the cephaline gregarines of Japan. (II). (3) Description of the members belonging to the families Didymophyidae, Actinocephalidae, Acanthosporidae, Stylocephalidae, Dactylophoridae. *Bull. Fac. Educ. Yamaguchi Univ*. **8:** 35-101

Hoshide K., Janovy J. Jr. (2002) The structure of the nucleus of *Odonaticola polyhamatus* (Gregarinea: Actinocephalus), a parasite of *Mnais strigata* (Hagen) (Odonata: Calopterygidae). *Acta Protozool*. **41:** 17-22

Kori S. S., Amoji S. D. (1983) On the life history of a new actinocephalid gregarine, *Odonaticola crocothemis*, sp. nov. from the midgut of an odonate insect, *Crocothemis servilia* (Drury). *The Ind. Zoologist* **7:** 155-158

Prasadanan P. K., Janardanan K. P. (1994) On a new species of actinocephalid gregarine (Apicomplexa: Cephalina) from the dragonfly *Neurothemis fluvia* (Drury) of Kerala, India. *Fraseria* **1:** 7-10

Prema S., Janardanan K. P. (1991) Morphology and life cycles of two new species of cephaline gregarines (Apicomplexa: Cephalina) from odonate insects in Kerala, India. *Acta Soc. Zool. Bohemoslov*. **55:** 60-64

Sarkar N. K. (1981) On some actinocephalid gregarines (Apicomplexa: Eugregarinida) of odonate insects from West Bengal, India. *Proc. Ind. Acad. Sci.* (*Anim. Sci.*) **90:** 649-657

Sarkar N. K., Haldar D. P. (1981) Observations on four new species of actinocephalid gregarines (Protozoa: Sporozoa) under a new genus *Odonaticola* from odonate insects. *Arch. Protistenk*. **124:** 288-302

Sprague V. (1941) Studies on *Gregarina blattarum* with particular reference to the chromosome cycle. *Ill. Biol. Monogr*. **18:** 5-57

Tillyard R. J. (1917) The Biology of Dragonflies. Cambridge University Press, Cambridge

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