Historical Account

Part - I
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In 1708 it was Redi, the illustrious scientist of Italy, who for the first time discovered what was possibly a gregarine (Watson, 1916). Subsequently in 1787, Cavalini also noticed the parasitic gregarines in animals. The first authentic report of ‘Gregarinosis’ from an arthropod host has been associated with name of Dufour (1928), who also established the first genus of Gregarines, gregarine. This genus now contains numerous species. In 1903, Minchin made an outline history of gregarines. Since then, pursuits of scientists have been continuing and considerable reports of genera and species and explicit accounts of complete life history of gregarines have been obtained as a result of their pursuits.

Koiliker (1884) brought out an elaborate memoir on the group and was perhaps the first to see the organisms in Syzygy (Though he thought it to be longitudinal fission). In 1899, Labbe listed about 55 certain and 13 uncertain genera (Containing 105 certain and 90 uncertain species). Noteworthy contribution on the biological and historical aspects of these interesting organisms were made by Dufour (1826, 1828, 1887), Siebold (1889), Stein (1848), Lankester (1863), Schneider (1873, 1875, 1882, 1886), Nutschii (1882), Frenzel (1885, 1892), Leger (1892, 1899, 1906), Brendt (1902), Minchin (1903),

Crawley (1903a, 1903b, 1907), Hall (1907), and wellmer (1911), Ellis (1912a, 1912b, 1912c, 1912d, 1913a, 1913b, 1913c), published lists concerning new species from arthropods of North and South America. Ishii (1914), for the first time, examined now rather well studied flour beetle, Tribolium sp. And reported four Polycystid gregarines: Gregarina cuneata, G. minuta, G. crassa and Steinina obconica.
Sokolow (1911a, 1911b, 1912) and Watson (1916b, 1916c), laid special emphasis on the physiology, morphology and reproduction of gregarines in general. Watson (1916a) conducted and elaborate survey on all the previous literature on gregarines. Prior to the publication of her monograph on the gregarines of the world, only eight families of cephaline gregarine viz. Acanthosporidae Leger, Actinocephalidae Leger, Dactylophoridae Leger, Didymophyidae Leger, Menosporidae Leger, Stylocephalidae Ellis and Stenophoridae Leger and Duboscq were known. Afterwards the same author (Kamm-Watson, 1918, 1921, 1922), recorded anew genus Bullbocephalus and nineteen new species from various insects of the United States and also created there new families, viz. lecudinidae, polyrhabdinidae and Cephaloidophoridae, Pinto (1918), threw light on two more new species of gregarines from coleopteran insects in Brazil.

Vincent (1922, 1924a, 1924b) recorded three new species from coleopteran insects in England and established one new genus Anisolobus from a coccinellid beetle. Zwtkow (1929, 1930) reported two more new species of gregarines from coleopterans in the USSR.

Henry (1933) created a new family kofoidimidae to include the genus Kofoidina which was previously described under the family Lecudinidae kamm. Two new families, viz. Monoductidae and Hyalosporinidae were created by Ray and Chakravarty (1933) and Chakravarty (1935) in India. However, Bhatia (1938) merged the family Hyalosporinidae Chakravarty with the family Stenophoridae Leger and Duboscq. Voluminous contribution on the field of taxonomy is credited to Adams and Travis (1935), Forester (1938a, 1938b), Semans (1936, 1939, 1941, 1943), Sprague (1941), Moriggi (1943), Carini (1944), Gibbs (1946), and Goobrich (1949), Sprague (1941), for the first time studied the chromosome cycle of Gregarina blattarum von sieboid. Harry (1965) studied the early development of
**Gregarina gamhami.** Major work done by Filliponi (1947, 1948, 1950, 1951a, 1951b, 1951c, 1953, 1955) who also established a new family *Gigaductidae* to accommodate a new species *Gigaductus macrospora*. Ball (1938, 1950, 1951, 1959, 1963) and Stein (1960) studied the gregarine parasites from marine crustacean and Ball (1938) also created a new genus carcinocoetes.


Corbel (1968) created a new genus *Boliviana* and five new species belonging to the genera *Gregarina Gigaductus* and *Leidyana*, Lipa (1967) made an extensive study of gregarine parasites of arthropods of Poland and described five new species from crustaceans of Baikal lake in 1968. Baudoin (1967, 1968) worked on gregarines belonging to two families, *Gregarinidae* and *Actinocephalidae*, from aquatic insect larvae and in 1971 created a new genus *Rizoinella*.


species in soil arthropods. Hanuala and Andreadis (1988) reported a few species from adults and larvae of the family Scarabaedae from 49 locations in Connecticut during the fall of 1988. Theodorides (1988) listed the gregarines in the coleopteran family Chrysomelidae all of which, according to him, belong to the families Gregarinidae, Hirmocystidae and Actinocephalidae.

In the last decade of the 20th century, several protozoologists from the U.S.A. under the dynamic leadership of Prof. John Janovy, Jr. made significant contributions in the field of septate Gregarinology. In 1990, Janovy, Jr. along with Ruhnke discovered the differences in the life history of two species of Gregaraina in Tenebriomolitor larvae. In the same year, Janovy Jr. and Richardson discovered Actinocephalus carrilynnae n.sp. from the blue damsel – fly, Enallagma civile (Hagen). In 1992, Gregarina coronate n.sp. (Apicomplexa : Eugregarinidae) was described from adults of the Southern Corn Rootworm, Diabrotica undecimpunctata howardi (Coleoptera : chrysomelidae) by Clopton Percival and Janovy, Jr. also discovered Nubenocephalus nebraskensis n. gen n.sp. an actinocephaiid from the adults of Argia bipunctulata. An odonate. In 1993, Clopton an Janovy, Jr. also gave an account of the developmental niche structure in the gregarine assemblage parasitizing Tenebrio molitor. Pereival, clopton and Janovy, Jr. described two new menosporine gregarines, Hoplorhynchus acanthatholius n.sp. and Steganorhynchus dunwoodyi n. gen. n.sp. (Apicomplexa actinocephalidae) from coenagrionid damsel flies (odonata : zygoppera) in 1995. In 1997, Watwood, Peterson, Addison and Janovy, Jr. described Gregarina triboliorum n.sp. from Tribolium confusum and found out the resolution of the confused taxonomic history of Gregarina minuta Ishii, 1914. In the year 2000, wise, Janovy, Jr. and Wise found the host specificity in Metamera
sillasenorum n.sp., gregarine parasite of the leech *Helobdella triserialis* and also gave an information on its transmission dynamics.

In 1991, clopton et al. described *Gregarina niphadrodruedes* n.sp. from adult *Tenebrio molitor* (L.) with oocyst description of some other gregarine parasites. Clopton (1995) established a new genus, *Domadracunculus* from some adult odonates in Texas, Janovy Jr. and his collaborators came out with two more publications: Schwang and Janovy (1991) discussed the response of *Gregarina niphadrodruedes* to host starvation in the adult of *Tenebrio molitor* and Cook et al. (2000) described the epimerite host epithelium relationship among engregarines parasitizing some damsel flies.

During their expedition to Southeast Asia from 1996 to 1998, a team of experts headed by Hoshide K. with Halder, D.P. as a member has recorded a number of septate gregarines from different types of insects in Thailand and Indonesia. Final reports are expected shortly.

Separate gregarines have been subjected to extensive research under the transmission and scanning electron Microscopy although neither TEM nor SEM studios have been done in the present investigation a few important references in this regard can be cited here. Beams et al. (1957) studied the ultrasturcture of the nuclear membrane of a gregarine parasite of grasshoppers. Tronchin and Schrevel (1977) studied the chronology of the development of the sporozoite in *Gregarina blaberae* under the TEM. Schrevel (1968, 1969, 1970, 1971, 1972). Schrevel and Vivier (1966), Schrevel et al. (1974), Vivier (1968), Vivier and Hennre (1965, 1972), Reger (1967), Hoshide (1973), Desportes (1974), Hlidebrand (1983), Hoshide and todd (1993, 1996) are some of the authors to mention who have significantly contributed to the understanding of the ultrastructure of eugregarines. The SEM study was emploid for the study of gregarine movement by Vavra and Small (1969), Walker et al. (1979), Hoshide
(1975) and many other Hoshide and Todd (1996) also studied the cell surface of hair like projections of the gamonts of *Filipodium ozakii*. Recently, Hoshide and Janovy Jr. (2002) studied the nuclear structure of odonaticola ployhamatusl under the transmission and scanning electron microscopy. Hoshide et al. (1993) studied the in Vitro excystation of the oocysts of *Gregarina blattar*.

In India, the first research on septate gregarines was carried out by Bhatia and Setna (1924) who reported some new species. Subsequently important contributions came from Ray and Chakravarty (1933, 1936). They worked on the life history of *stenophora khagendrae* and *Monoductus lunatus* from dipiopods. Chakravarty (1934, 1935, 1936, 1939) reported some new species and created a new genus *Hyalosporina*. He (Chakravarty 1959) also systematized some genera and classified the suborder Cephalina. Later, many new species were reported by Misra (1941, 1942), Ganapati and Mrityunjaya Devi (1954), Ganapati and Narasimhamurti (1956, 1960). Ball (1959) and Rodgi and Ball (1961) and Rodgi and Ball (1961), Bhusana Rao (1962), Rodgi and Amoji (1969) and Amoji and Rodgi (1970, 1972, 1973, 1976).


Prema and Janardanan (1987) recorded a new species *Grebnekiella ramachandrani* from a centipede host, *Scolopendra morsitans* Linn. and in 1991, prema and Janardanan also established two new species of *Cephaline gregarines* from Odonate insects.

Haldar et al. (1979), Haldar and Sarkar (1979, 1980, 1981a,b,c,d,e and f) and Sarkar (1979, 1981a, 1981b, 1983) after an extensive work on odonate insect pests found a number of new species of *Cephaline gregarines*, belonging to the genera *Liposcelisus, Menospora, Retractocephalus, Hoplorhynclus, Actionocephalus, Teractinospora, Acanthospora, Ancyrophora, Ramicephalus* and *Odonaticola of which the genera Liposcelisus, Tetractinospora* and *Odonaticola* were established by them. Sarkar (1985) reported two new septate *Gregarines, pyxinia reneae* and *Gregarina chaetocnemate* from some Coleopteran insects. He also established the genera *Crucoccephalus* and *Harendraia* in the same year. Datta and Hardar (1984) and Kundu and Haldar (1981a, 1981b, 1981c, 1983, 1984a, 1984b) worked on eight new cephaline gregarines belonging to the genera *Gregarina, Hirmocystis, Quadrospinospora, Brustiospora, Quadruhyalodiscus* and *Amphiplatyspora* of which the last three

For the first time, Haldar et al (1988) reported a species of *Ansolobus* in India from Coccinellid beetle, which they named *A. indicus*. In the same year (1988), they erected a new genus *Laterospora* to include the species *Laterospora phenacocca*.

Prema and Janardanan (1989) erected a new genus *Stephnospora* to accommodate stephanospora, paratelphusae. One year later they introduced two new species of Cephaline gregarines from the marine prawns *penaeus indicus*. In the same year after extensive investigation, Datta et al. reported seven new species of the genus *Didymophyes*, *Hirmocystia* and *Quadrospinospora* from orthopteran insects of West Bengal.

In the year 1996, Sengupta and Haldar recorded three new species of Septate gregarines of the genus *Gregarina Dufour* (1928) viz., *G. hyashii* from *Coccinella transversalis*, *G. vannucephala* from Gryllopedes sp. And *G. coptosomae* from Coptosoma sp. One year later, another new species of the genus *Gregarina*, *G. sitophlli* has been reported from a stored grain pest *Sitophilus oryzae* by Saha et al. (1997).

In continuation of their work on the prevalence and biodiversity of the Septate gregarines from insects in West Bengal, Haldar and his collaborate, have come out with several publications.


Chatterjee and Haldar (2001) also described a new species of \textit{Laterospora} from an Orthopteran nymph in 2003 they have established a new genus, \textit{Quadruknobsopora} also from a grasshopper.

Modak and Haldar (2001, 2002, 2003) also published reports on the septate gregarines from some known insect pests of West Bengal.

Haldar and Biswas (2002) described the structure and life history of three new species of septate gregarines from odonates.


Ghosh et al. (1986) after a bioecological study pointed out that various environmental factors like temperature, humidity and rainfall have a direct influence on the incidence of infection of gregarines. Ghosh et al. (1987) reported three different species belonging to the genus *Didymophyes* from the common pest, *Oryzaephilus mercator* F. They concluded these variations as the cause due to the change of food items consumed by the hosts.

Before the 20th century the studies on the pathogenecity of septate gregarines upon their hosts were not traced by the scientests. From the very begining of the last century significant contributions in this field have been by Laveran and Mesnil (1900), Leger and Duboscq (1904), Minchin (1912), Watson (1975a), Manwell (1977), Haldar (1978), Sarkar (1978), Janardanan and Ramachandran (1982a) and Haldar et al. (1987).

Besides founistic aspects of investigation, Lipa (1967) studied the nature of infections in the host organisms caused by Protozoans as well as their role in the dynamics of host populations. Kundu et al. (1980) worked on the effects of physical and chemical agents on the development of gametocytes of gregarines of coccinellid beetles. The
effect of temperature on the formation, maturity and viability of sporocysts of ten cephaline gregarines infesting tenebrionid insects have been shown by Patil et al. (1983). Later in 1985 they studied the cross infection of cephaline gregarines in tenebrionid insects.

In 1985, Dallal and Tulluri studied the trophozoites of Gregarina sp. by the conventional transmission electron microscopy and freeze-fracture technique.

The review of literature on the separate gregarines shows that a huge number of papers have been published on various aspects of the group so far and many are expected in the coming years. Nelson (1970) has rightly remarked “The literature on gregarines has slowly accumulated over the years. There has been no phenomenal explosion. Similar to that which has occurred in many other areas of science. In all likelihood, the literature will continue its slow growth. There are almost many new species of gregarines, yet to be discovered.”