Rev. Biol. Trop., 28(2): 297-304, 1980

# Studies on the host range of the endophytic alga *Cephaleuros* Kunze in India

by

G. Jose* and Y.B.K. Chowdary*

(Received for publication February 28, 1980)

**Abstract:** Plants so far reported to be infected by the endophytic alga *Cephaleuros* in India are listed. Infection occurs as dark-reddish or brown-greenish spots on the dorsal surface of leaves. The alga undergoes considerable variation under different conditions on the same host. Severe attacks of the alga occurred during the rainy season. The morphological variation of the alga is discussed.

The genus *Cephaleuros* is a well-known parasitic or endophytic alga which at times causes serious damage to cultivated crops. A disease caused by this alga on tea plants is known as "Red Rust of Tea", and is a serious problem in plantations in India (Cunningham, 1879) and Indonesia (Hubert, 1957). This disease is more prevalent in north-eastern India. Mann and Hutchinson (1907) identified *C. virescens* as the causative agent and said that *Cephaleuros* began to attract attention since 1880 as the cause of "white blight", a serious disease of tea and other tropical plants of economic value. Sharples (1923) reported *C. virescens* as a causative agent of black fruit disease of pepper vines in Sarawak.

The alga has a wide distribution in tropical and sub-tropical regions (Joubert and Rijkenberg, 1971). In India as early as 1879 Cunningham reported the occurrence of the alga as *Mycoidea parasitica* on tea plantations from Assam and in 1897 he re-recognized the same alga as *C. virescens* Kunze. Since then many workers have reported its occurrence on various hosts. In this paper we wish to list all hitherto known plants infected by this alga.

## OBSERVATIONS AND DISCUSSION

List of plants infected by *Cephaleuros* Kunze

| Name of the hosts | Locality | Observer |
|---|---|---|
| *Acacia lenticularis* | Assam | Sarmah, 1960 |
| *Achras sapota* | Mysore | Safeeulla & Govindu, 1948 |

* Department of Botany, Banaras Hindu University, Varanasi-221005, India.

| Name of hosts | Locality | Observer |
|---|---|---|
| *A. sapota* | Bihar | Yadav, 1955 |
| *A. sapota* | Tamil Nadu | Vidhyasekaran & Prambaramani, 1971 |
| *Adenanthera pavonina* | Assam | Sarmah, 1960 |
| *Alangium salvifolium* | Bihar | Bhargava *et al.*, 1966 |
| *Albizzia stipulata* | North Eastern Dt. | Mann & Hutchinson, 1907 |
| *A. chinensis* | Assam | Sarmah, 1960 |
| *A. lebbek* | Bihar | Yadav, 1953 |
| *A. lebbek* | Uttar Pradesh | Bhargava *et al.*, 1966 |
| *A. lebbek* | Assam | Sarmah, 1960 |
| *A. odoratissima* | Assam | Sarmah, 1960 |
| *A. procera* | Assam | Sarmah, 1960 |
| *A. sumatrana* | Assam | Sarmah, 1960 |
| *Alstonia scholaris* | Bihar | Yadav, 1953 |
| *A. scholaris* | U.P. | Bhargava *et al.*, 1966 |
| *Alysicarpous bupleurifolius* var. *erecta* | Bihar | Das, 1979 |
| *Anacardium occidentale* | Kerala | Jose & Chowdary, 1977 |
| *Anthurium* sp. | Mysore | Safeeulla & Govindu, 1948 |
| *Arecanut* sp. | Kerala | Menon, 1960 |
| *Artocarpus integrifolia* | Bihar | Yadav, 1955 |
| *A. lakoocha* | U.P. | Bhargava *et al.*, 1966 |
| *Artocarpus* sp. | Kerala | Jose & Chowdary, 1977 |
| *Azadirachta indica* | U.P. | Bhargava *et al.*, 1966 |
| *Bridelia retusa* | U.P. | Bhargava *et al.*, 1966 |
| *B. stipularis* | U.P. | Bhargava *et al.*, 1966 |
| *Barrigtonia acutangula* | Bihar | Yadav, 1953 |
| *B. acutangula* | U.P. | Bhargava *et al.*, 1966 |
| *Bassia latifolia* | Bihar | Yadav, 1955 |
| *Bauhinia racemosa* | Mysore | Safeeulla & Govindu, 1948 |
| *B. variegata* | Bihar | Yadav, 1955 |
| *Bombax malabaricum* | Bihar | Yadav, 1955 |
| *Buchanania latifolia* | Bihar | Yadav, 1955 |
| *B. lanzan* | U.P. | Bhargava *et al.*, 1966 |
| *Butea frondosa* | Bihar | Yadav, 1953 |
| *B. monosperma* | U.P. | Bhargava *et al.*, 1966 |
| *Caesalpinia crista* | Bihar | Yadav, 1955 |
| *C. crista* | U.P. | Bhargava *et al.*, 1960 |
| *Calathea metallica* | North-Eastern Dt. | Karsten, 1891 |
| *Callistemon lanceolatus* | Mysore | Safeeulla & Govindu, 1948 |
| *Camellia japonica* | North-Eastern Dt. | Cunningham, 1897 |
| *C. japonica* | North-Eastern Dt. | Mann & Hutchinson, 1907 |
| *C. japonica* | Mysore | Safeeulla & Govindu, 1948 |
| *Canarium commune* | Mysore | Safeeulla & Govindu, 1948 |
| *Capparis zeylanica* | U.P. | Bhargava *et al.*, 1966 |
| *Carrissa carandus* | Mysore | Safeeulla & Govindu, 1948 |
| *C. carandus* | Bihar | Yadav, 1953 |
| *C. spinarum* | U.P. | Bhargava *et al.*, 1966 |

| Name of hosts | Locality | Observer |
|---|---|---|
| *Carica papaya* | U.P. | Garg, 1951 |
| *Cassia fistula* | Bihar | Yadav, 1955 |
| *C. fistula* | U.P. | Bhargava *et al.*, 1966 |
| *C. javanica* | Bihar | Yadav, 1955 |
| *C. serattensis* | U.P. | Bhargava *et al.*, 1966 |
| *Catha edulis* | Mysore | Safeeulla & Govindu, 1948 |
| *Chrysophyllum cainito* | Mysore | Safeeulla & Govindu, 1948 |
| *Cinnamomum iners* | North-Eastern Dt. | Cunningham, 1897 |
| *Cissampelos pareira* | U.P. | Bhargava *et al.*, 1966. |
| *Citrus medica* | Bihar | Yadav, 1953 |
| *Cleodendron infortunatum* | Bihar | Yadav, 1953 |
| *C. viscosum* | U.P. | Bhargava *et al.*, 1960 |
| *Combretum decandrum* | Bihar | Yadav, 1955 |
| *Cordia myxa* | Bihar | Yadav, 1953 |
| *C. dichotma* | U.P. | Bhargava *et al.*, 1966 |
| *Croton* sp. | North-Eastern Dt. | Cunnigham, 1897 |
| *Crotalaria aragyroides* | Assam | Sarmah, 1960 |
| *C. brownei* | Assam | Sarmah, 1960 |
| *Dalbergia latifolia* | Bihar | Yadav, 1955 |
| *D. assamica* | Assam | Sarmah, 1960 |
| *D. sissoo* | U.P. | Bhargava *et al.*, 1966 |
| *Derris robusta* | Assam | Sarmah, 1960 |
| *Desmodium gyroides* | Assam | Sarmah, 1960 |
| *D. gangeticum* | U.P. | Bhargava *et al.*, 1966 |
| *Diospyros tomentosa* | U.P. | Bhargava *et al.*, 1966 |
| *Duabanga sonneratioides* | Mysore | Safeeulla & Govindu, 1948 |
| *Eriobtorya japonica* | Bihar | Yadav, 1955 |
| *Erythrina suberosa* | Bihar | Yadav, 1955 |
| *Eugenia jamoliana* | Bihar | Yadav, 1953 |
| *Ficus benjamina* | Mysore | Safeeulla & Govindu, 1948 |
| *F. benghalensis* | Bihar | Yadav, 1955 |
| *F. benghalensis* | U.P. | Bhargava *et al.*, 1966 |
| *F. benghalensis* | Varanasi (U.P.) | Jose & Chowdary, 1977 |
| *F. elastica* | U.P. | Bhargava *et al.*, 1966 |
| *F. glomerata* | U.P. | Bhargava *et al.*, 1966 |
| *F. hispida* | U.P. | Bhargava *et al.*, 1966 |
| *F. macrophylla* | Mysore | Safeeulla & Govindu, 1948 |
| *F. nervosa* | Bihar | Yadav, 1955 |
| *F. religiosa* | U.P. | Bhargava *et al.*, 1966 |
| *F. religiosa.* | U.P. | Jose & Chowdary, 1977 |
| *F. religiosa* | U.P. | Bhargava *et al.*, 1966 |
| *F. rumphi* | U.P. | Bhargava *et al.*, 1966 |
| *Flacourtia indica* | U.P. | Bhargava *et al.*, 1960 |
| *Funtumia elastica* | Mysore | Safeeulla & Govindu, 1948 |
| *Giliricidia sepium* | Assam | Sarmah, 1960 |
| *Grewia asiatica* | U.P. | Bhargava *et al.*, 1966 |
| *Haplophragma adenophyllum* | U.P. | Bhargava *et al.*, 1966 |
| *Ichnocarpus frutescens* | U.P. | Bhargava *et al.*, 1966 |

| Name of hosts | Locality | Observer |
|---|---|---|
| *Ilex paraguaensis* | Mysore | Safeeulla & Govindu, 1948 |
| *Indigofera dosua* | Assam | Sarmah, 1960 |
| *I. teysmani* | Assam | Sarmah, 1960 |
| *Ixora undulata* | Bihar | Yadav, 1955 |
| *Jambusa vulgaris* | Mysore | Safeeulla & Govindu, 1948 |
| *Lagerstroemia indica* | Bihar | Yadav, 1955 |
| *L. speciosa* | U.P. | Bhargava *et al.*, 1966 |
| *Laurus robilis* | Mysore | Safeeulla & Govindu, 1948 |
| *Limnathemum indicum* | North-Eastern Dt. | Cunningham, 1897 |
| *Loranthus longiflorus* | Mysore | Safeeulla & Govindu, 1948 |
| *(Dendrophthoe falcata)* | Bihar | Yadav, 1953 |
| *(Dendrophthoe falcata)* | U.P. | Bhargava *et al.*, 1966 |
| *(Dendrophthoe falcata)* | U.P. | Jose & Chowdary, 1977 |
| *Macrangia denticulata* | Bihar | Yadav & Srivasthva, 1957 |
| *Madhuca indica* | U.P. | Bhargava *et al.*, 1966 |
| *Madhuca indica* | U.P. | Jose & Chowdary, 1977 |
| *Mallotus philippinensis* | U.P. | Bhargava *et al.*, 1966 |
| *Magnolia glauca* | Bihar | Yadav, 1953 |
| *M. grandiflora* | Bihar | Yadav, 1953 |
| *M. grandiflora* | Shillong | Jose & Chowdary, 1977 |
| *M. grandiflora* | U.P. | Jose & Chowdary, 1977 |
| *Mangifera indica* | North-Eastern Dt. | Cunningham, 1897 |
| *M. indica* | North-Eastern Dt. | Butler, 1918 |
| *M. indica* | Mysore | Safeeulla & Govindu, 1948 |
| *M. indica* | U.P. | Jose & Chowdary, 1977 |
| *Melia azedarach* | Assam | Sarmah, 1960 |
| *Michelia champae* | Mysore | Safeeulla & Govindu, 1948 |
| *Millitea auriculata* | Bihar | Yadav & Srivastava, 1957 |
| *Morinda tinctoria* | Bihar | Yadav, 1955 |
| *Morus alba* | Bihar | Yadav, 1955 |
| *Murraya exotica* | Bihar | Yadav, 1953 |
| *M. koenigii* | U.P. | Bhargava *et al.*, 1966 |
| *Nephelium litchi* | Bihar | Yadav, 1953 |
| *Nyctanthes arbortristis* | Bihar | Yadav, 1955 |
| *Ochrocarpus longifolius* | Mysore | Safeeulla & Govindu, 1948 |
| *Parkia javanica* | Assam | Sarmah, 1960 |
| *Peltophorum ferrugineum* | Mysore | Safeeulla & Govindu, 1948 |
| *Pergularia pallida* | U.P. | Bhargava *et al.*, 1960 |
| *Persea gratissima* | Mysore | Safeeulla & Govindu, 1948 |
| *Phytolacea diocia* | Mysore | Safeeulla & Govindu, 1948 |
| *Piper longum* | Bihar | Yadav and Srivastava, 1957 |
| *P. nigrum* | Kerala | Jose & Chowdary, 1977 |
| *Plecospermum spinosum* | Mysore | Safeeulla and Govindu, 1948 |
| *Polyalthia longifolia* | U.P. | Safeeulla and Govindu, 1948 |
| *Polyalthia longifolia* | Bihar | Bhargava *et al.*, 1960 |
| *Priotropis cytisoides* | Assam | Sarmah, 1960 |
| *Psidium guajava* | U.P. | Chowdary, 1959 |
| *P. guajava* | Tamil Nadu | Vidhyasekaran & Parambaramani, 1971a. |

| Name of hosts | Locality | Observer |
|---|---|---|
| *Pterospernum acerifolium* | U.P. | Bhargava *et al.*, 1966 |
| *Putranjiva roxburghi* | U.P. | Bhargava *et al.*, 1966 |
| *Pyrus malus* | Bihar | Yadav, 1955 |
| *Pyrus* sp. | U.P. | Jose & Chowdary, 1977 |
| *Rhododendron* sp. | North-Eastern Dt. | Cunningham, 1897 |
| *Salmalia malabarica* | U.P. | Bhargava *et al.*, 1966 |
| *Sapindus mukorossi* | U.P. | Bhargava *et al.*, 1966 |
| *Schleichera triguga* | U.P. | Bhargava *et al.*, 1966 |
| *Scutia myrtina* | Mysore | Safeeulla & Govindu, 1948 |
| *Shorea robusta* | U.P. | Bhargava *et al.*, 1966 |
| *Similax roxburghiana* | U.P. | Bhargava *et al.*, 1966 |
| *Sterculia alata* | Bihar | Yadav, 1953 |
| *Streblus asper* | U.P. | Bhargava *et al.*, 1966 |
| *Swietenia macrophylla* | Bihar | Yadav and Srivastava, 1957 |
| *Syzigium jabolanum* | Mysore | Safeeulla & Govindu, 1948 |
| *S. heyneanum* | U.P. | Bhargava *et al.*, 1966 |
| *Tamarindus indica* | Bihar | Yadav, 1955 |
| *Tecoma stans* | Bihar | Yadav, 1955 |
| *Tectona grandis* | U.P. | Bhargava *et al.*, 1966 |
| *Tephrosia candida* | Assam | Sarmah, 1960 |
| *T. vogelil* | Assam | Sarmah, 1960 |
| *Terminalia arjuna* | U.P. | Bhargava *et al.*, 1966 |
| *T. belerica* | U.P. | Bhargava *et al.*, 1966 |
| *T. chebula* | U.P. | Bhargava *et al.*, 1966 |
| *T. tomentosa* | U.P. | Bhargava *et al.*, 1966 |
| *Thea sinensis* | North-Eastern Dt. | Cunningham, 1897 |
| *T. sinensis* | North-Eastern Dt. | Mann & Hutchinson, 1907 |
| *T. sinensis* | North-Eastern Dt. | Tunstall, 1942 |
| *T. sinensis* | Bihar | Yadav, 1953 |
| *T. sinensis* | Assam | Sarmah, 1960 |
| *T. sinensis* | Tamil Nadu | Vidhyasekharan & Parambaramani, 1971 |
| *T. sinensis* | Darjeeling | Jose & Chowdary, 1977 |
| *Tiliacora acuminata* | U.P. | Bhargava *et al.*, 1966 |
| *Treuia nudiflora* | U.P. | Bhargava *et al.*, 1966 |
| *Urena lobata* | U.P. | Bhargava *et al.*, 1966 |
| *Xylosma longifolium* | Mysore | Safeeulla & Govindu, 1948 |
| *X. longifolium* | U.P. | Bhargava *et al.*, 1966 |
| *Ziziphys jujuba* | North-Eastern Dt. | Karsten, 1891 |
| *Z. jujuba* | Bihar | Yadav, 1955 |
| *Z. nummularia* | U.P. | Bhargava *et al.*, 1966 |
| *Z. oenoplia* | U.P. | Bhargava *et al.*, 1966 |
| *Monocot* | | |
| *Pandanus* sp. | North-Eastern Dt. | Karsten, 1891 |
| *Pothos scandens* | Kerala | Jose & Chowdary, 1977 |
| *Gymnosperm* | | |
| *Podocarpus* sp. | Darjeeling | Jose & Chowdary, 1977 (New report) |

Species of *Cephaleuros* are usually found on the dorsal surface of smooth, leathery leaves and persist for relatively long periods on perennial plants. The vegetative thallus of the alga is disc-like and is easily recognized as slightly raised dull green, brownish, yellow or red spots or patches, the dimensions of which vary on different hosts. The disc-like thallus is one-to-many layered thick, with symmetrically arranged cells in the upper layers. The cells are elongate or barrel-shaped. Filaments with apical growth radiate dichotemously and centrifugally. The sections through infected regions show that the alga is mostly subcuticular in origin. In parasitic forms, rhizoid-like structures penetrate into the intracellular spaces of the palisade tissue of the host leaves. The epidermis is destroyed in some places. Of the 14 species of *Cephaleuros* reported so far, only 2 *(C. parasiticus* and *C. coffeae)* are reported as parasitic. Das (1979) postulated that fertile species of *Cephaleuros* behave as parasites, and sterile species as epiphytes.

It is not known whether *Cephaleuros* depends totally on the host for its nutrients. Studies on the carbon, nitrogen and mineral metabolism of algal infected leaves of Achras, Guava and Mango by Vidhyasekaran and Parambaramani (1971a, b, 1972) show reductions in glucose, sucrose, total protein, ammoniacal nitrite, aminoamide nitrogen, potassium, phosphorus and sulphur content of infected leaves. However, fructose, starch, cellulose, nitrate glutamic acid, alanine and sodium increase in algal infected leaves. It is quite possible that the alga may depend on the host for some of its nutrients if not all of them.

In an earlier study, we accounted for the seasonal variations on the occurrence of the alga on seven local hosts around Varanasi. Severe attacks of alga occurred during the rainy season (July-Sept.). Stalked sporangia which were abundant during this season disappeared in the months of March-April when sessile sporangia were abundant. There was a considerable variation in areas of algal infected regions in these two periods.

It is evident now from earlier studies that the alga exhibits extreme plasticity under different environmental conditions on the same host or similar conditions on different hosts. This has made the identification of alga very difficult. The alga that occurs on *Mangifera, Psidium, Thea* has been identified as *C. virescens* (Islam, 1972) while some consider it as *C. parasiticus* (Vidhyasekaran and Parambaramani, 1971a; Satyanarayana and Baruha, 1976). It is not clear whether the variation is a result of genotypic expressions or environmental conditions. A study undertaken by Jose and Chowdary (1977) on 14 isolates of *Cephaleuros* from 12 hosts has shown that the morphological variation need not necessarily be accompanied by chromosomal variation, although this occurred in a few cases. A conclusion in this regard is possible only by studying large numbers of isolates from different geographical regions.

## LITERATURE CITED

**Bhargava, K.S., R.D. Joshi, & M. Kamal**
1966. Occurrence of *Cephaleuros* in Gorakhpur. Ind. Forest., 92: 589-90.

**Butler, E.J.**
1918. Fungi and diseases in plants. Calcutta. Thacker. 547 p.

**Cunninghan, D.D.**
1879. On *Mycoidea parasitica* a new genus of parasitic algae, and the part which it plays in the formation of certain lichens. Trans. Linn. Soc. London. Bot. Ser. 2, 1: 301-316.

**Cunningham, D.D.**
1897. On certain diseases of fungal and algal origin affecting economic plants in India. Sci. Mem. Med. Officers Army India, 10: 95-130.

**Chowdary, Y.B.K.**
1959. Cytology of *Trentepohlia* and *Cephaleuros*. Proc. Symp. Algol., 65-69.

**Das, R.N.**
1979. A comparative host-parasite relationship of *Cephaleuros* over two angiospermic hosts. 66th Ind. Sci. Congr. (Abst.).

**Garg, D.N.**
1951. Some new diseases of economic plants in the Uttar Pradesh. Agri. Animal Husb., Uttar Pradesh 1: 12-14.

**Hubert, F.P.**
1957. Diseases of some export crops in Indonesia. Plant Dis. Rep., 41: 55-63.

**Islam, A.K.N.M.**
1972. Subaerial algae of Bangladesh. Bangladesh J. Bot., 1: 13-64.

**Jose, G., & Y.B.K. Chowdary**
1977a. Effect of some herbicides and fungicides on the isolates of *Cephaleuros* in culture. *In* Physiology of Microorganisms Today & Tomorrow. New Delhi-11.

**Jose, G., & Y.B.K. Chowdary**
1977b. Karyological studies on *Cephaleuros* Kunze. Acta Bot. Indica, 5: 114-122.

**Joubert, J.J., & F.H.I. Rijkenberg**
1971. Parasitic green algae. Ann. Rev. Phytopathol., 9: 45-64.

**Karsten, G.**
1891. Untersuchungen uber die Familie der Chroolepideen. Ann. Jard. Bot. Buitenzorg, 10: 1-65.

**Mann, H.H., & C.M. Hutchinson**
1907. *Cephaleuros virescens* Kunze. The Red Rust of Tea. Mem. Dep. Agr. India. Bot. Ser., 1: 1-23.

**Menon, P.R.**
1960. An algal parasite (*Cephaleuros* kunze) on a recanut palm. Arecanut. J., 11: 17-19.

**Safeeulla, K.M., & H.C. Govindu**
1948. Some new hosts of *Cephaleuros*. J. Mysore Univ., Sec. B., 11: 47-49.

**Sarmah, K.C.**
1960. The diseases of tea and associated crops in N.E. India. Tocklai Exp. Sta. Indian Tea. Assoc. Mem., 26: 1-68.

**Satyanarayana, G., & G.C. Baruha**
1976. 'Red rust' an important disease of tea. 63rd Sess. of Ind. Sci. Cong., p. 141 (Abst.)

**Sharples, A.**
1923. Report on "Black Fruit" disease of pepper vines in Sarawak. Malay-Agri. J., 11: 120-128.

**Tunstall, A.C.**
1942. "Red Rust" Tocklai Exp. Sta. Indian Tea Assoc. Mem., 14: 1-19.

**Vidhyasekaran, P., & C. Parambaramani**
1971a. Carbon metabolism of alga infected plants. Ind. Phytopathol., 24: 369-374.

**Vidhyasekaran, P., & C. Parambaramani**
1971b. Nitrogen metabolism of alga infected plants. Ind. Phytopathol., 24: 500-504.

**Vidhyasekaran, P., & C. Parambaramani**
1972. Mineral metabolism of alga infected plants. Ind. Phytopathol., 25: 86-90.

**Yadav, A.S.**
1953. Some new hosts of *Cephaleuros* from Bihar. Curr. Sci., 22: 280.

**Yadav, A.S.**
1955. Some new hosts of *Cephaleuros* from Bihar. Curr. Sci., 24: 124.

**Yadav, A.S., & J.G. Srivastava**
1957. Some new hosts of *Cephaleuros* from Bihar. Proc. 44th Ind. Sc. Cong., 3: 216.