

The Fungus Genus *Alternaria* Nees. in Bombay-Maharashtra II*).

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(With 16 figs.)

A b s t r a c t.

This is the second contribution on the subject giving morphological descriptions and characterizations of 16 spp. of the genus *Alternaria* (including one variety) based on fresh collections made by the writer at Poona and adjoining regions with general notes on this genus of great economic importance. The text is illustrated with 16 figures.

I n t r o d u c t i o n.

The writer undertook a comprehensive and systematic survey into the fungus *Alternaria* as it occurs in Bombay-Maharashtra State, during the years 1960—64 and collected over 100 hosts for this important genus. A study of these collections revealed many new host records, a few spp. new to Science and also new records to India.

The genus *Alternaria* Nees. (established by C. G. Nees, 1817), is of great economic importance inciting such severe types of diseases like leaf spots, blights (foliar as well as blossom) and even defoliations in plants. It infects many economic garden plants, agricultural crops etc., and has therefore attracted considerable attention from many phytopathologists and mycologists all over the world in respect of pathology, physiologic specialisation, host range, taxonomy and control measures.

This paper presents detailed characterizations with full illustrations of 16 Indian species.

The earlier part deals with 20 species bringing the total number of Indian species of *Alternaria* collected and studied by the writer to 36, distributed among 33 host-families. *Alternaria tenuis* Auct,

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which is a highly cosmopolitan species with a wide, host range has not been included in the present contribution and has been dealt with separately.

Description of species:

1. *Alternaria lini* Dey. (Fig. 1).

Syn.: *A. tenuis* Auct.

Dey, P. K. Indian J. agric. Sci. 3 (5): 881—896; 1933.

P. Neergard; Danish species of *Alternaria* and *Stemphylium*, 1945.

Infection spots small, dark-brown to black, mostly marginal to apical, generally on the lower leaves and proceeding upwards.

Conidiophores dark-brown, septate (1—4), simple, solitary or in groups of 2—3, slightly bulged at base, scarred and rounded at apex, measure $16.8—42 \times 5.25—6.3 \mu$.

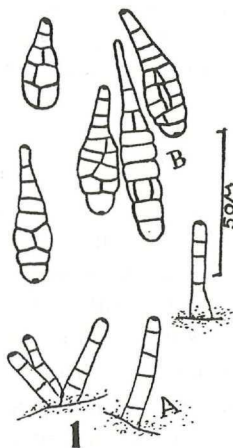


Fig. 1. *Alternaria lini*; A = Conidiophores; B = Conidia.

Conidia dark olive, clavate to muriform, catenulate (2—7) with a short rudimentary beak, 1—4 longitudinal and 4—8 cross septa with constrictions at cross walls, scarred at apex, measure $29.4—81.9 \times 14.7—19 \mu$.

Incites leaf spots and blight in *Linum usitatissimum* L. collected by Vasant Rao (24—12—1963), Poona.

This species was first described by Dey (1933) from Cawnpore (U. P.), India causing a severe blight of linseed. Neergard (1945) has reduced this species to Synonym with *A. tenuis* Auct.

Arya and Prasada (1952) considered this species as *A. brassicae* (Berk) Sacc.

Cross inoculation experiments would be needed to clarify the exact position regarding the diagnosis of this species.

2. *Alternaria longipes* (Ellis et Everh.) Mason (Fig. 2).

Syn.: *Macrosporium longipes* Ell. and Everh.

Sacc. **11**: 635: 1895.

Mason, E. W., Ann. List. Fungi; I. B. M. List **2** (1): 19; 1928.

Infection spots irregular, scattered, leathery, few concentric, deep-chocolate-brown, marginal.

Conidiophores dark-brown, straight to slightly bent, solitary or in groups of 2—5, bulged at the base rounded and scarred at apex, 1—5 septate, non constricted at septa, emerge through rupturing the diseased tissue, rarely through stomata, measure $19.9\text{--}50.4 \times 5.2\text{--}6.5 \mu$.

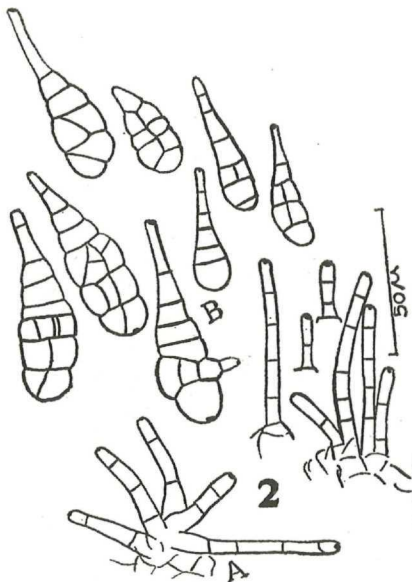


Fig. 2. *Alternaria longipes*; A = Conidiophores; B = Conidia.

Conidia light olive-brown clavate or obclavate to muriform, with a short beak, scarred at base and apex, with 0—4 longitudinal and 4—6 cross septa, constricted at septa, catenulate (2—5), measure $37.8\text{--}75.6 \times 12.6\text{--}20 \mu$.

Incites leaf spots in *Nicotiana tabacum* L. collected by Vasant Rao (21—10—1963), Poona.

This fungus has also been reported from Delhi (India) on *Nicotiana rustica* (Butler and Bisby, Fungi of India; 1960).

3. *Alternaria macrospora* Zimmermann. (Fig. 3).

Sacc. **19**: 41; 1910.

Rane and Patel: Indian Phytopath. **9** (2): 105—113; 1956.

Infection spots round to irregular, pale to dark-brown, scattered,

marginal, with slightly raised margin, forming irregular large patches in severe cases.

Conidiophores short, dark-brown, scarred at apex, rounded and bulged at base, solitary or in fascicles of 2—3, straight or slightly bent, emerge through rupturing the epidermis or through stomata, 2—4-septate measure $50-85 \times 4.2-6.5 \mu$.

Conidia pale-brown, elongate, with a long septate filiform beak, with 2—4 longitudinal and 4—7 cross septa, constricted scarred at the base, solitary, measure $75.6-190 \times 12.6-17.7 \mu$. (including beak); beaks measure $42-134.5 \times 3.15-4.2 \mu$.

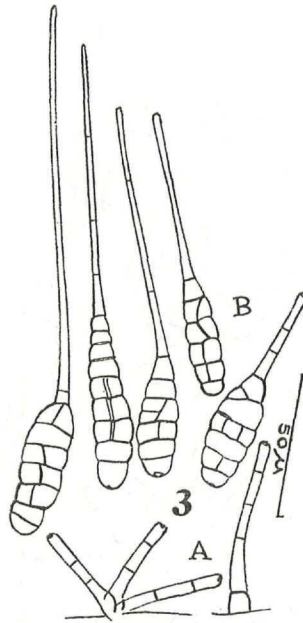


Fig. 3. *Alternaria macrospora*; A = Conidiophores; B = Conidia.

Incites leaf spots in *Gossypium hirsutum* L. collected by Vasant Rao (11—10—1961), Poona.

In some collections of the hosts collected by the writer, *A. tenuis* was found associated producing typical dark-brown, irregular infection spots, characterised by muriform conidia with rudimentary beaks, in long chains of 10—15, strongly scarred at base and apex typical of the species.

Rane and Patel (1956) investigated this disease in Bombay State in respect of varietal resistance in host, determination of the organism and control measures.

4. *Alternaria mali* Roberts.

(Fig. 4).

Roberts: agric. Res. **11**: 58: 1914.

Infection spots epiphyllous, pale, chocolate-brown, sometimes zonate, scattered, few marginal, oval to irregular.

Conidiophores short, simple, septate (1—4), mostly solitary rarely in fascicles of 2—6, scarred at apex slightly bulged at base straight to slightly bent, dark-brown emerge out through stomata or bursting the epidermis, measure $25.2\text{--}79.8 \times 4\text{--}5.25 \mu$.

Conidia pale olivaceous-brown, obclavate to muriform, catenulate (2—6), scarred at the base and apex, with 1—2 longitudinal and 4—6 cross septa, constricted at cross septa, measure $25.5\text{--}46.2 \times 11.4\text{--}13 \mu$.

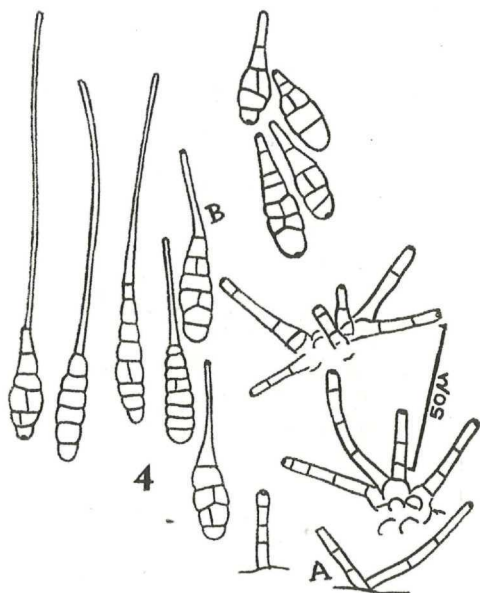


Fig. 4. *Alternaria mali*; A = Conidiophores; B = Conidia.

Incites leaf spots in *Pyrus malus* L. collected by Vasant Rao (22—12—1963), Poona.

Some of the collections made by the writer from this host showed close association of a species of *Alternaria*, not definitely determined but quite distinct from *A. mali* Roberts, in having conidia with long, hyaline, septate beaks, borne singly on conidiophores. The conidia of this species measured $78\text{--}162.0 \times 10.5\text{--}12.6 \mu$ (with beak). Beaks $29.4\text{--}130.2 \times 3.15\text{--}4.2 \mu$.

A. mali Roberts. has close resemblance to *A. tenuis* Auct, and is often referred to in literature as a form of *A. tenuis* viz. f. *mali*.

A. mali constitutes a new addition to the Fungi of India.

5. *Alternaria poonensis* Raghunath (Fig. 5).

Mycopath. et. Mycol. Appl. **21** (3—4): 315—317, 1963.

Infection spots epiphyllous, dirty dark-brown to black, oval to irregular (2—6 mm), scattered, marginal, often coalescing to produce large necrotic areas and blights.

Conidiophores simple, rarely branched, erect, dirty-brown, 2—4 septate, non-constricted, emerge out singly or in fascicles (2—4) bursting the host tissue or through stomata with prominent apical scar, measure 21—85 × 6.3—8.5 μ.

Conidia solitary, clavate, dark-brown with long septate beak, with 0—4 longitudinal and 5—9 transverse septa, constricted at cross septa, few oblique septa, rounded base with a scar, measure 58.8—201.6 × 8.5—21 μ.

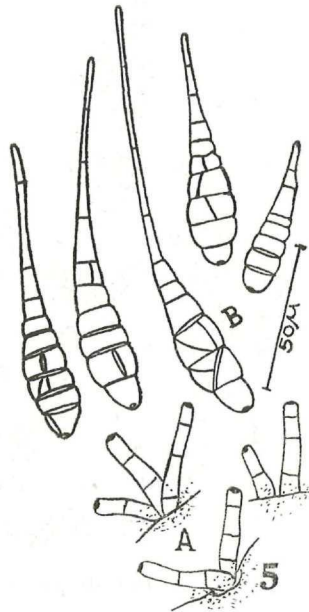


Fig. 5. *Alternaria Poonensis*; A = Conidiophores; B = Conidia.

Incites leaf spots and blight in *Coriandrum sativum* L. collected by Vasant Rao (21—11—1963), Poona, India.

The fungus has been found distinct from *A. burnsii* and *A. dauci* on morphological grounds pathogenicity and host specificity as reported by Raghunath (1963).

6. *Alternaria pimpriana* Vasant Rao (Fig. 6).

Curr. Sci. **32**: 84—85, 1963.

Infection spots epiphyllous, circular with concentric rings, brownish, scattered, measuring 6—10 mm.

Conidiophores simple, mostly solitary, multiseptate (1—7), emerge out through the epidermis, rarely through stomata, constricted, geniculate, dark-brown, rounded at apex, with a terminal scar, $21-63 \times 5.2-8.5 \mu$.

Conidia solitary, obovate to obclavate, 5—13 transverse septa, 1—2 longitudinal septa, drawn out into a long beak, which is hyaline, non-septate, un-branched, nearly three times the length of the conidia, not constricted at septa, double-walled, pale-brown, $205.8-260.5 \times 12.5-17.0 \mu$ (with beak).

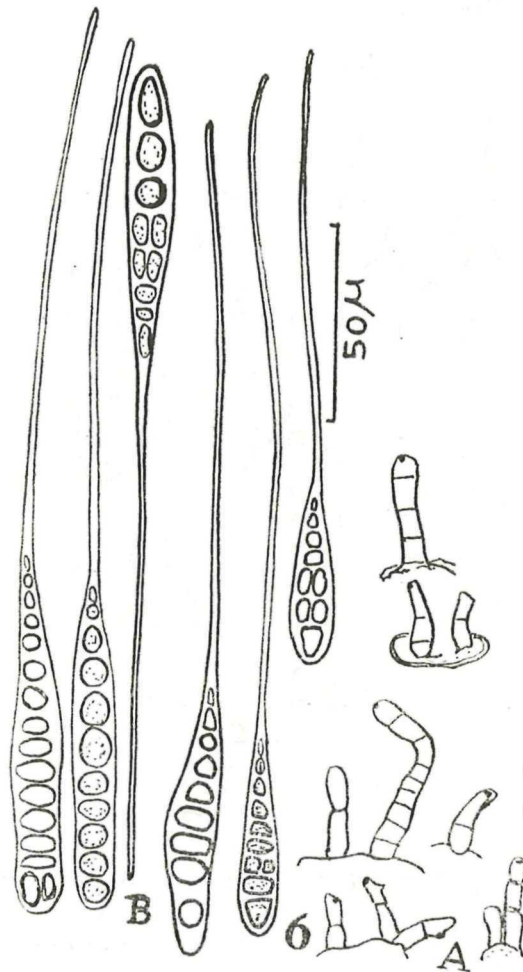


Fig. 6. *Alternaria pimpriana*; A = Conidiophores; B = Conidia.

Incites leafspot and blight of *Celosia cristata* L. Collected by Vasant Rao (4—8—1961) at Pimpri, Poona M. A. C. S. Mycol. Herb. No. 110 (Type).

This species was compared with *Alternaria amaranthi* (Peck.) Venkata. and *Macrosporium celosiae*, F. Tassi. and was found to be significantly distinct and accommodated in a new taxon.

7. *Alternaria raphani* Groves and Skolko. (Fig. 7).

Canad. J. Res. Sec. C. **22**: 227; 1944.

Wiltshire, S. P.; C. M. I. Paper **20**: 14; 1947.

Infection spots amphigenous circular (3—8 mm), rarely irregular, dark-brown, scattered.

Conidiophores dark-brown, simple, short, solitary or in groups of 2—3, 2—4 septate, scarred and rounded at the apex, slightly bulged at the base, emerge out by rupturing the epidermis and measure $42-75.6 \times 4-6.5 \mu$.

Conidia yellowish-brown, obclavate to elongate with a short septate to non-septate beak, scarred at apex, mostly solitary, rarely in chains of 2—4; with 2—10 longitudinal and 5—10 cross septa, constricted at septa, measure $65-130.2 \times 14.7-23.1 \mu$.

Incites leaf spots in *Raphanus sativus* L. collected by Vasant Rao (7—8—1962), Poona.

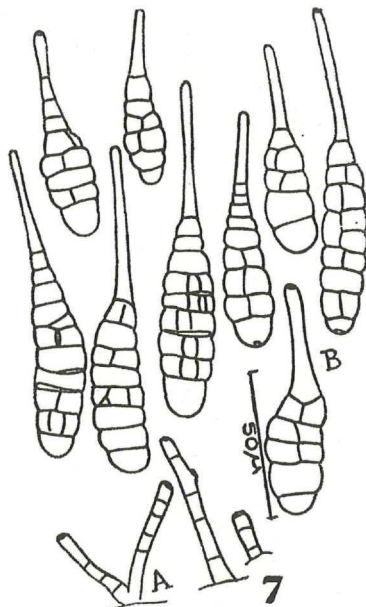


Fig. 7. *Alternaria raphani*; A = Conidiophores; B = Conidia.

Wiltshire (1947) considered the species to be very closely related to *A. brassicae* (Berk.) Sacc. and reduced it to synonymy with the latter on the basis of comparative studies.

A. raphani is a new record for Bombay-Maharashtra.

8. *Alternaria ricini* (Yoshii) Hansford. (Fig. 8).

Syn.: *Macrosporium ricini* Yoshii.

Yoshii: Bull. Sci. Fak. Terkult. Kjusu Imp. Univ. Fakuoka. Japan. **3**: 327—332; 1929.

Hansford: Proc. Linn. Soc. London. 155th Session: 34—67 (1942—43).

Infection spots irregular, scattered, pale brown to dark olivaceous-brown, sometimes with concentric rings, few marginal, 3—12 mm. often coalescing to produce irregular patches resulting in blights.

Conidiophores erect, straight to slightly bent, bulged at the base, rounded and scarred at the apex, solitary or in groups of 2—3; 1—3 septate, non-constricted at septa, olivaceous in colour, emerging by rupturing the epidermis, measure $30-113.4 \times 7.35-8.4 \mu$.

Conidia obclavate, light olive-brown, mostly solitary, very rarely in chains of 2—3 with hyaline non-septate to septate long rigid beaks, having 2—9 longitudinal and 5—12 cross septa constricted, typically muriform with many oblique septa, double-walled measure $168-344.4 \times 29.4-42.7 \mu$ including beak. Beaks measure $75.6-231 \times 3.15-4.2 \mu$.

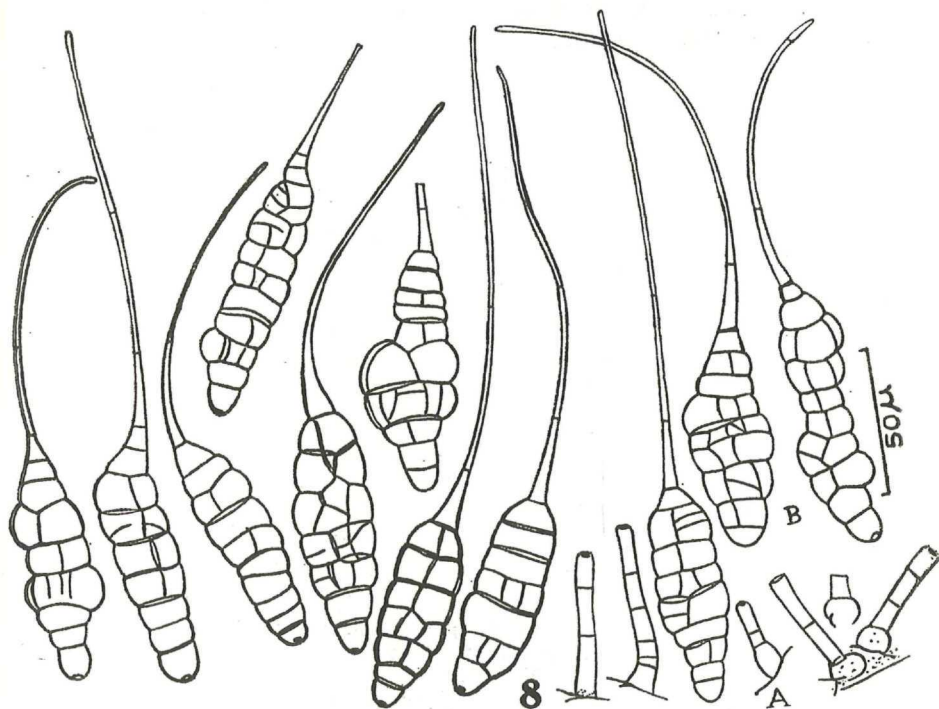


Fig. 8. *Alternaria ricini*; A = Conidiophores; B = Conidia.

Incites leaf spots and blight in *Ricinus communis* L. collected by Vasant Rao (20—9—1963), Poona.

In some collections, *A. tenuis* Auct. was found associated with dark olive-brown, small irregular to zonate spots, Conidia measuring $35.7-60.9 \times 12.6-18.9 \mu$.

9. *Alternaria rumicicola* Mathur, Agnihotri and Tyagi (Fig. 9).

Curr. Sci. **31**: 297; 1962.

Infection spots epiphyllous, dirty-brown, few per leaf, scattered, mostly marginal, oval to irregular.

Conidiophores short, dark-brown, bulged at base, straight to slightly curved, scarred at apex, solitary or in groups of 2—5, unbranched, emerge through the epidermis or stomata, 1—4 septate, measure $25.2-75.6 \times 4.2-6.5 \mu$.

Conidia yellowish-brown, fusoid to obclavate, pale brown, with 0—5 longitudinal and 6—12 transverse septa, slightly constricted at transverse septa, with medium septate beaks, in short chains, with terminal and basal scars, measure $46.2-113.4 \times 12.0-19 \mu$. (including beak). Beaks septate, pale brown, measure $17-46.2 \times 3.5-5.2 \mu$.

Incites leaf spots in *Rumex vesicarius* L. collected by Vasant Rao (9—9—1963), Poona.

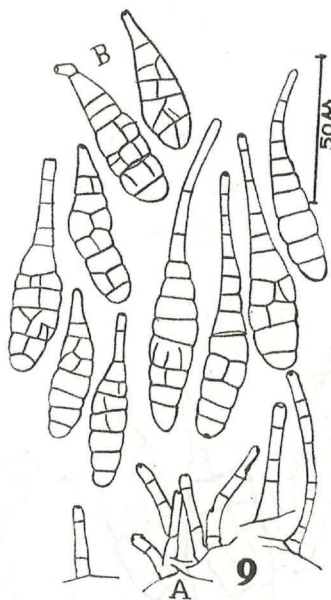


Fig. 9. *Alternaria rumicicola*; A = Conidiophores; B = Conidia.

This species was described recently by Mathur et al (1962) causing leaf spot in *Rumex* sp. from Udaipur (Rajasthan, India) and is a new addition to fungi of Bombay.

10. *Alternaria sesami* (Kawamura) Mohanty and Behera (Fig. 10).

Syn.: *Macrosporium sesami* Kawamura.

Mohanty and Behera: Curr. Sci. **27** (2): 492—493; 1958.

Infection spots brown to dark-brown, round to irregular, mostly marginal and apical, 2—10 mm. when young, later coalescing to form large irregular necrotic patches often with concentric zonations, resulting in defoliation.

Conidiophores simple, erect to slightly bent, bulged at base, rounded and scarred at apex, yellowish-brown, solitary or in fascicles of 2—5, 2—6 septate, non-constricted at septa, emerge through rupturing the host tissue or the stomata, measure $25-75.6 \times 4.5-6.3 \mu$.

Conidia obclavate, yellowish-brown to dark olivaceous-brown, in short chains of 2—3, scarred at base and apex with long septate, narrow beaks, 5—11 transverse septa with constrictions in conidial walls, 2—5 longitudinal septa, measure $77.7-147 \times 12.6-16.8 \mu$ (including beak). Beaks long, hyaline, septate, measure $25.2-90 \times 3-4.2 \mu$.

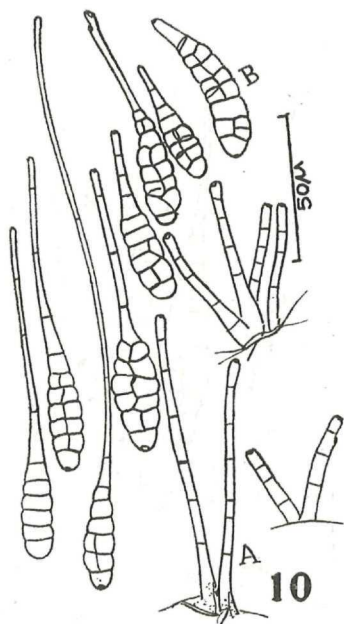


Fig. 10. *Alternaria sesami*; A = Conidiophores; B = Conidia.

Incites leaf spots and blights in *Sesamum indicum* L. collected by Vasant Rao (10—10—1962), Poona.

A. sesami is a new record for Bombay-Maharashtra.

11. *Alternaria solani* (Ellis and Mart.) Jones & Grout.

Fig. 11 C & 11 T).

Syn.: *Macrosporium solani* Ell. and Mart.

Jones and Grout: Bull. Torrey bot. Cl. **24**: 254—258, 1897,
Sacc. **4**: 530; 1878.

Infection spots circular to irregular, dirty dark-brown, sometimes, with concentric rings, rough, scattered to marginal, measuring 3—7 mm. In severe cases producing blighting effect.

Conidiophores dark-brown, thick-walled, straight to slightly bent, mostly solitary, rarely in groups of 2—3, scarred rounded and slightly geniculate at apex, broader near the base, 2—4 septate, slightly constricted, emerge out through the epidermis or the stomata, measure $37.8-67.2 \times 5.2-6.3 \mu$.

Conidia obclavate to elongate, pale olivaceous-brown, catenulate, with very long, filiform, branched septate beak, double-walled,

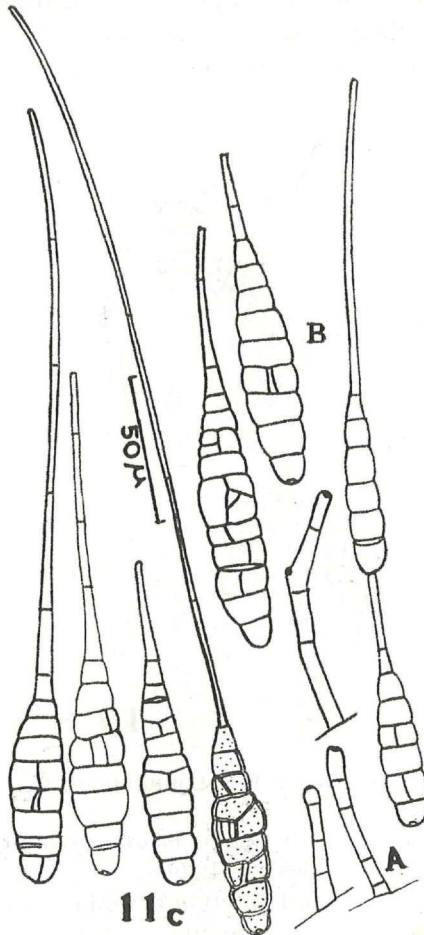


Fig. 11 C. *Alternaria solani* from *Chilli* leaves; A = Conidiophores; B = Conidia.

rarely scarred at the base, with 1—5 longitudinal and 5—11 cross septa, slightly constricted at cross septa, measure $138.6-441 \times 12.6-21.5 \mu$ including the beak, sometimes measuring upto 756μ in length. Beaks are filiform, hyaline to pale brown, septate and branched.

Incites leaf spots and blights in *Capsicum annuum* L. *Lycopersicon esculentum* Mill., *Nicandra physaloides* Gaertn. *Solanum melongena* L., *S. tuberosum* L. collected by Vasant Rao, (4-12-1961), Poona.

A. solani in its characteristic form was found to incite leaf spot and blight in all the hosts except in *Solanum melongena* L. and *S. tuberosum*, where this species was found to be of rare occurrence.

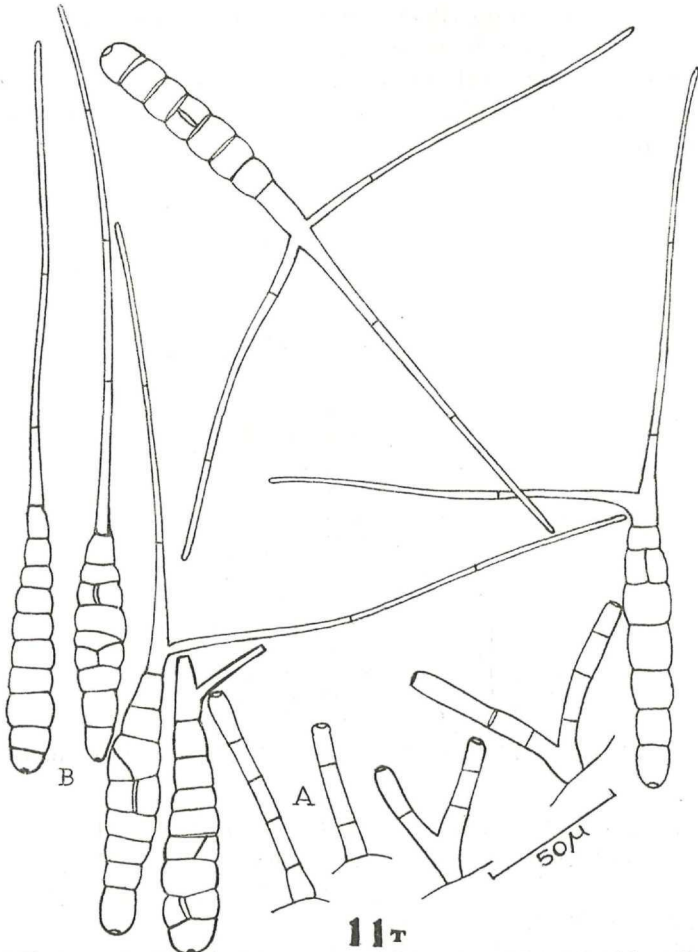


Fig. 11 T. *Alternaria solani* from *Tomato* leaves. (Note the bi and tri furcation of beaks.) A = Conidiophores; B = Conidia.

On the other hand *A. tenuis* Auct. was the predominant species associated with the „early blight“ in *Solanum tuberosum* L. in this State.

The occurrence of *A. solani* on the common weed host *Nicandra physaloides* Gaertn. not only constitutes a new report but is of great significance from the point of view of persistence of the pathogen and its mode of overwintering.

12. *Alternaria sonchi* Davis and Elliott (Fig. 12).
Davis and Elliott: Bot. Gaz. **62**: 416; 1916.
Sacc. **25**: 864; 1931.
Anonymous, „British Records“, Trans. Brit. mycol. Soc. **42**
(1): 118—119; 1959.

Infection spots small, epiphyllous, irregular, scattered to marginal, dark-brown.

Conidiophores epiphyllous, dirty-brown, septate (2—5), simple, mostly solitary, rarely in groups of 2—4 scarred at apex, few geniculate, non-constricted at septa, generally emerge through rupturing the diseased tissue, straight to slightly bent and measure $29\text{--}84 \times 4.2\text{--}8.5 \mu$.

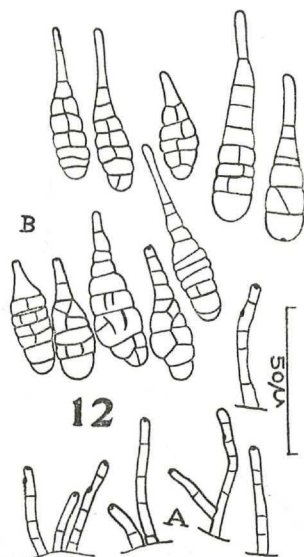


Fig. 12. *Alternaria sonchi*; A = Conidiophores; B = Conidia.

Conidia clavate to obclavate, pale brown, few with short septate beaks, catenulate 2—3, 2—5 longitudinal septa and 5—10 cross septa, with constrictions in walls, scarred at base and apex, measure $45\text{--}120 \times 9\text{--}22 \mu$.

Incites leaf spots in *Sonchus oleraceus* L. and *Lactuca sativa* L. collected by Vasant Rao (2—8—1961), Poona.

Lactuca sativa L. is an important leafy vegetable and widely grown in this country and is annually subject to the leaf blight disease incited by *A. sonchi*.

The conidia obtained from this host are smaller ($25.2\text{--}92.4 \times 8.4\text{--}17 \mu$), than those on *Sonchus oleraceus* L. *A. sonchi* is a new host record for this species for Bombay-Maharashtra.

13. *Alternaria spinaciae* Allesch. and Noack. (Fig. 13).
Bolet. Instit. Agron. Estado. de Sao Paulo. **9** (2): 83; 1898.
Sacc. **16**: 1080; 1902.

Singh and Gupta. Curr. Sc. **20**: 104—105; 951.

Infection spots dirty dark-brown, scattered, oval to irregular, rarely marginal with a definite slightly raised brick-red to dark margins, 4—9 mms.

Conidiophores dark brown, septate, (2—6) scarred at apex, straight to slightly curved, mostly solitary, rarely in fascicles of 2—3, emerge through the stomata, measure 52.5—92.4 × 5.25—6.5 μ.

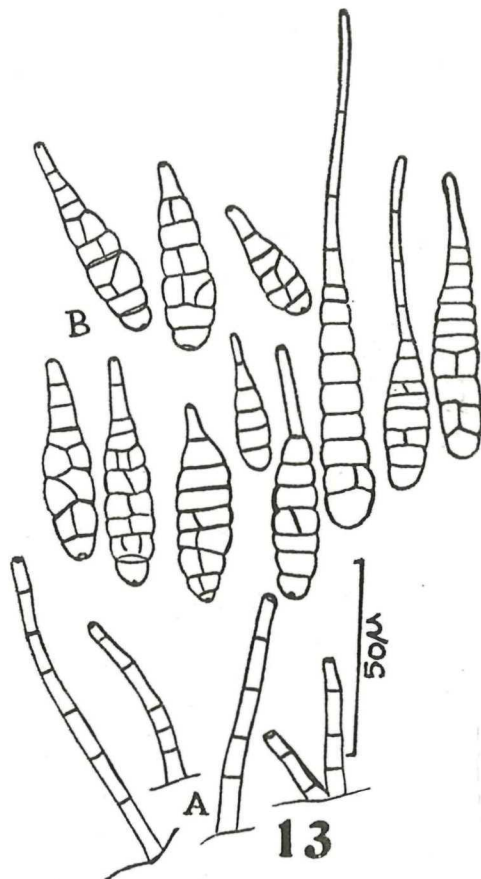


Fig. 13. *Alternaria spinaciae*; A = Conidiophores; B = Conidia.

Conidia elongate to clavate, pale greenish-brown, with a short beak, scarred at apex, catenulate (2—4), with 0—6 longitudinal and 5—10 cross septa, constricted at cross septa, measure 42—134.4 × 12.5—15.75 μ.

Incites leaf spots in *Spinacia oleracea* L. collected by Vasant Rao (28—8—1962), Poona.

Remarks: This species is a new record for Bombay-Maharashtra.

14. *Alternaria triticicola* Vasant Rao (Fig. 14).
Mycopath. et. Mycol. Appl., 1964 (In Press).

Infection spots yellowish-brown to dark-brown, epiphyllous,

oval to irregular, scattered, many marginal, often coalescing to produce large necrotic areas.

Conidiophores dark olivaceous-brown, rigid, short, simple, prominently scarred (1 to 3), rounded at apex, bulged at base, in fascicles of 2 to 10 often upto 20, closely aggregated at base and divergent at top; emerging through the host tissue or stomata, $21-105 \times 5.25-7.35 \mu$.

Conidia pale olivaceous-brown, irregularly-celled, obclavate to muriform, somewhat bulged in the centre, with rounded to narrow base, tapering towards apex into a medium septate simple beak, mostly solitary rarely in short chains (2 to 3), with 2 to 7 longitudinal and 6 to 12 cross septa, with oblique septa confined to the basal portion, constricted, with a basal scar, measuring $63-172.2 \times 21-35.7 \mu$ (with beak).

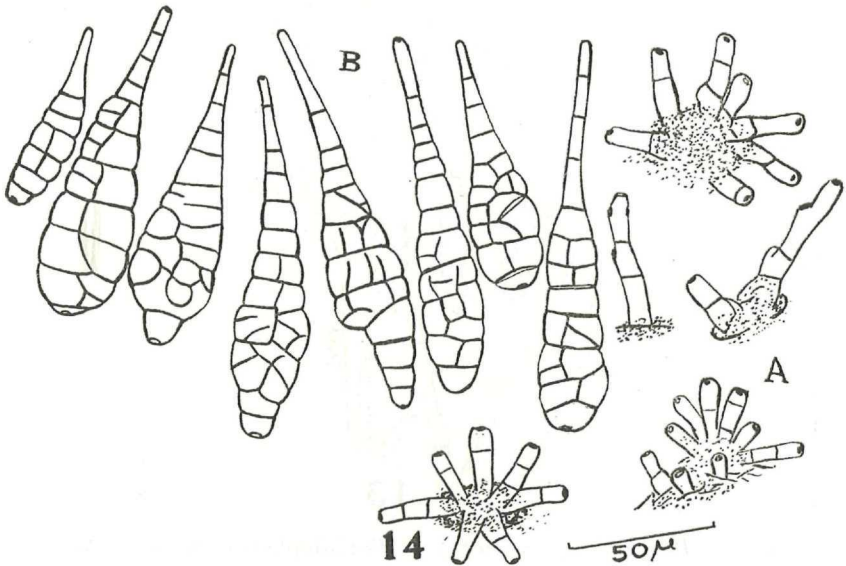


Fig. 14. *Alternaria triticicola*; A = Conidiophores; B = Conidia.

Incites leaf spots and blight in *Triticum aestivum* L. collected by Vasant Rao (10-11-1962), Poona M. A. C. S. Mycol. Herb. No. 186 (Type).

15. *Alternaria zinniae* Pape (Fig. 15).

Pape, H. Angrew. Bot.: **24**: 61-72; 1942.

Dimok A. W. and J. H. Osborn: Phytopathology **33**: 372-381; 1943.

Chona B. L. and J. N. Kapoor: Curr. Sci. **25** (11): 375; 1956.

Edward, J. C. Sci. and Cult. **22** (12): 683-684; 1957.

Agarwal, G. P. and V. Bhawe: *Curr. Sci.* **28** (7): 292—293; 1959.

Infection spots epiphyllous, brown, oval to irregular, scattered, 4 to 10 mm.

Conidiophores brown, septate, erect to slightly bent, simple, slightly bulged and scarred at apex, mostly solitary rarely in fascicles of 2—5, septate (2—6), measure $38-88.2 \times 4-9 \mu$.

Conidia fusoid to cylindrical, with a long filiform septate, simple, hyaline, straight to slightly curved and pointed beak, solitary, scarred at the base, olivaceous-brown, cross septa 5—9, longitudinal septa 2—4, double-walled, constricted and measure $117.6-243.0 \times 10.5-25.2 \mu$.

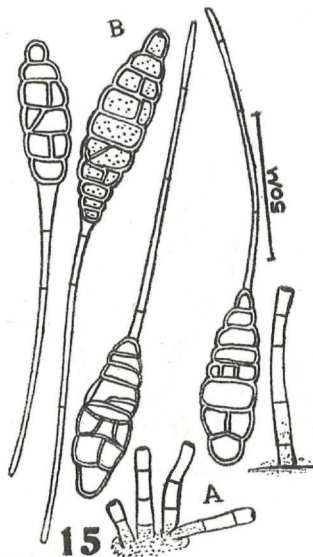


Fig. 15. *Alternaria zinniae*; A = Conidiophores; B = Conidia.

Incites leaf spots in *Zinnia elegans* Jacq., *Parthenium hysterophorus* L., *Ageratum conyzoides* L., *Blumea wightiana* DC., *Carthamus tictorius* L., *Helianthus annuus* L., *Tagetes erecta* L. and *Xanthium strumarium* L.

Alternaria zinniae has been found to be of frequent occurrence infecting host plants of the family *Compositae* and has a wide host-range only next to *A. tenuis* Auct.

This disease was found to be destructive in rainy season and at times in winter also. In addition to the folicular-spots, this fungus produces several types of blossom blights as well.

The disease was also of common occurrence in *Parthenium hysterophorus* L., a very common weed host recently introduced into India and causing serious damage to other forage crops.

16. *Alternaria tenuis* var. *rosicola* Vasant Rao.

(Fig. 16).

Mycopath. et Mycol. Appl. 1964 (In Press).

Infection spots epiphyllous, irregular, scattered, mostly marginal and apical, dark-brown to black, sometimes coalescing to produce large necrotic areas.

Conidiophores straight to slightly bent, dull-brown, septate (2—6), slightly constricted at septa, bulged at base and rounded and scarred at apex, emerging out through stomata or by rupturing the epidermis, solitary or in fascicles of 2—4, measure $37.8-84 \times 5.25-8.5 \mu$.

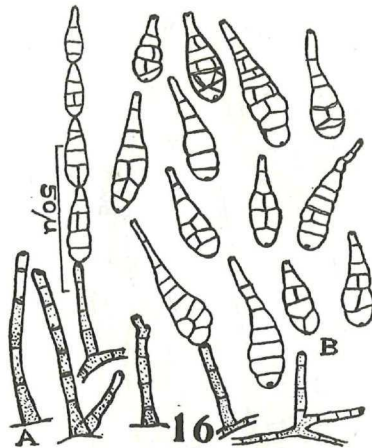


Fig. 16. *Alternaria tenuis* var. *rosicola* Vasant Rao;
A = Conidiophores; B = Conidia.

Conidia dark-brown, obclavate to muriform, with rudimentary to short beaks, scarred at base and apex, catenulate (3 to 8), with 0—5 longitudinal septa, 3—9 transverse septa, slightly constricted at septa, measure $30.45-80 \times 11.5-16.8 \mu$.

Incites leaf spots and defoliation in *Rosa* sp. collected by Vasant Rao (15—8—1963), Poona. M. A. C. S. Mycol. Herb. No. 201 (Type).

In nature, the fungus was found to infect a large number of varieties of Rose which include *Edward Rose*, *Crimson glory*, *Rajendra Prasad*, *President Hoover*, *Red cabbage*, *Concerto Margarate*, *Devoniensis*, *La France*, and *Lavenier*.

General Discussion.

The present study mainly deals with the characterization of the genus *Alternaria* occurring in the State of Bombay-Maharashtra (India), based on the examination of fresh collections made by the writer

during the years 1960—1964. The study gives an account of each species with its detailed characterization and determinations on the basis of comparative morphology, conidial characters and host-range, with an emphasis on the variation and morphological pattern of each species and their range of variation in respect of conidiophores and conidial characters. No type material was examined or consulted in the determination of species.

This survey and study has been fruitful in the discovery of many new hosts for *Alternaria* spp., several species new to this State or new records to India and 6 spp. and one variety new to Science.

Many morphological variations were also encountered in some species and even found to be influenced by environment, nutrition and host, often creating confusion in the determination of the species.

In this State *Alternaria radicina* Meyer, Dreschler and Eddy. was frequently referred and listed in the literature as the causal agent of leaf spots in *Daucus carota* L., but the present studies have indicated that this species was not at all found in the collections made by the writer from the State, the causal fungus in these cases being found to be *A. dauci* (Kuhn) Groves and Skolko.

The collections made by the writer in Bombay-Maharashtra can be generally grouped under the three main heads as defined recently by Neergaard (1945) as: —

- (a) Longicatenatae (Long-chained) (1 sp.) *A. tenuis* Auct.
- (b) Brevicatenatae (Short-chained) 28 spp.) The rest of the spp.
- (c) Noncatenatae (Non-chained) (7 spp.) viz. *A. burnsii*; *A. crassa*, *A. dauci*, *A. pimpriana*, *A. macrospora*, *A. poonensis* and *A. zinniae*.

A very interesting observation probably with great significance is the occurrence of *A. zinniae* Pape on the common widespread and obnoxious weed plant, *Parthenium hysterophorus* L. where this species was found to cause a very serious blight with the possibility of controlling the obnoxious weed through biological methods by the application of fungal sprays.

The occurrence of *A. solani* on a common but widely distributed weed plant *Nicandra physaloidis* Gaertn. is indeed very significant and probably plays an important role in the recurrence of the disease and oversummering of the pathogen.

A. zinniae Pape, was found to be next in order of *A. tenuis* in respect of its host range being present in seven host plants, often in association with other species of *Alternaria*, particularly *A. tenuis* Auct. and *A. carthami* Chow.

Another interesting observation of general occurrence and significance made through these studies was the association of more

than one species of *Alternaria* in the leaf spot lesions of the same hosts as in *A. carthami* with *A. zinniae* on *Carthamus tinctorius* L. *A. macrospora* with *A. tenuis* Auct., on cotton, *A. zinniae* with *A. tenuis* on sunflower, *A. gomphrenae* with *A. tenuis* on *Gomphrena globosa* L., *A. ricini* with *A. tenuis* on Castor bean; *A. solani* with *A. tenuis* on potato, tomato, chillies etc.

The importance of pure culture studies and artificial inoculation methods cannot be over-emphasised in the determinations of the true nature of this association, and the role each of these species plays in inciting the respective disease.

CONCLUSIONS.

This is primarily a taxonomic work of the genus *Alternaria* as it occurs in the State of Bombay-Maharashtra, India, based on fresh collections made by the writer during his four years of study i. e. 1960—64. The fungus genus which had only received casual and scattered attention in this State, has been studied collectively and much valuable information obtained, which would eventually be useful to future workers in the compilation of a monographic study of this important genus. The writer was able to collect as many as 36 species on about 92 host plants distributed among 33 host families with a detailed characterisation of the species accompanied by complete illustrations and determinations based on general morphological characters, dimensions of the conidiophores and conidia comparative studies conidial characters and host range.

It is interesting to note that the writer was able to collect and add as many as 23 spp. of *Alternaria* including six new spp. and one variety to Bombay Fungi. Besides many hosts were found to be new records to spp. of *Alternaria*. All the new species were collected on hosts of economic importance. The number of new records of species of *Alternaria* added to the Indian List is 9.

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