

Geotrichum candidum and pulmonary diseases

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Abstract. — *Geotrichum candidum* is a yeast-like filamentous fungus common in nature, which occasionally causes geotrichosis especially in the bronchopulmonary area.

The basic material of this study consisted of fungal cultures on many different culture media, of 6801 morning sputa and 1289 other bronchopulmonary specimens from patients chiefly with pulmonary disease. For purpose of comparison fungal cultures were additionally made of 1495 upper respiratory tract and 1711 faeces and gastric juice samples. The mean incidences of occurrence of *Geotrichum candidum* were 0.5 % in bronchial secretion, 1.8 % in morning sputum, 2.5 % in the upper respiratory tract, 2.6 % in gastric juice and 13.2 % in faeces.

Because of its commonness, the isolation of *Geotrichum candidum* from faeces hardly permit any conclusions. On the other hand, repeated abundant isolations from morning sputum and particularly from bronchial secretion in the course of months impart information of much greater significance.

Geotrichosis apparently is a more common mycosis than the approximately 60 cases in the literature indicate. It generally has a chronic, benign course and occasionally it may even heal spontaneously. Nevertheless it may cause considerable trouble when occurring as a secondary, opportunistic infection complicating some primary disease. The possibility of geotrichosis should therefore be held in mind better than heretofore has been the case.

Key words: *Geotrichum candidum* — yeast-like filamentous fungi — respiratory tract fungi — digestive tract fungi — fungal cultures — microfungi in pulmonary disease patients — geotrichosis.

Geotrichum candidum Link is a yeast-like filamentous fungus of world-wide distribution (Fig. 1) and a common saprophyte in, e.g., dairy products, foodstuffs especially when spoiled, dead vegetation, soil, and waste water (SAËZ 1957, MORENZ 1971). Particles of *Geotrichum candidum* also float in the air, but usually not in any abundance (RIPE 1962, cf. BADER 1965, WINDEN 1968). Strains isolated from plants and animals have been shown to be reciprocally pathogenic for both (SINCLAIR & EL-TOBSHY 1969). Animal pathogenicity, on the whole, has occasionally been considered questionable. The tissue reaction to *Geotrichum candidum* has been regarded to be similar in many respects to the foreign body reaction and often to be limited to the development mainly of minor suppurating foci and granulomas (SCHIEFER &

GEDEK 1969, WEGMANN 1969, GHAMANDE *et al.* 1971). In any case, the virulence of *Geotrichum candidum* is quite low and in most cases there probably is merely a colonisation of the fungus on the surface of an organ or lesion.

Geotrichum candidum is evidently to be classified among the facultatively pathogenic fungi capable of producing so-called opportunistic infections (DRACH *et al.* 1968, WEGMANN 1968, UTZ 1970). The infection usually is endogenous, but occasionally it may be exogenous. The world literature contains at least 24 cases of bronchopulmonary, 9 of bronchial, 12 of oral and 11 of cutaneous human geotrichosis, most of them in adults (MORENZ 1971). A closer identification of the *Geotrichum* species causing the mycosis was not made in some cases, however. The

only species of *Geotrichum* of greater significance for the human organism is probably *Geotrichum candidum*. A family endemic of five cases of pulmonary geotrichosis has been described from Norway (THJÖTTA & URDAL 1949). Some cases of *Geotrichum septicaemia* have also been published (WEBSTER 1959, CHANG & BUERGER 1964, SYMMER 1966). Reports of geotrichosis in animals are fewer in number than those of human cases (SCHIEFER & GEDEK 1969). However, a case of disseminated geotrichosis in a dog has been described, in which the lungs were most heavily affected and cultures from the bronchopulmonary area yielded *Geotrichum candidum* (LINCOLN & ADCOCK 1968).

In the human body, especially in the intestines, and in certain patient groups *Geotrichum candidum* is not infrequently encountered. It has been isolated from the faeces of nearly a half — and even more — of patients with skin disease and with gastrointestinal disturbances (MORENZ 1963, KRÖNERT 1969), but generally the incidence has been lower. LUNDELL (1970) isolated *Geotrichum candidum* from the feet of Finnish soldiers in about 10 % of those examined. In the respiratory tract the occurrence of this microfungus is usually of the order of 1-6 % but may rise, at least in the sputum of patients with pulmonary tuberculosis, as high as about 25 % (COUDERT et al. 1957, SAËZ 1957, MORENZ 1971).

The present investigation was undertaken with the object of studying the occurrence and significance of *Geotrichum candidum* especially in the bronchopulmonary area and in patients with respiratory diseases.

Material and methods

The basic material consisted of 8090 specimens from the bronchopulmonary tract. Fungal cultures were made of all samples. For comparative purposes, fungal cultures were also made of 1495 samples from the upper respiratory tract and 1711 faeces and gastric juice samples. The distribution of the material into subgroups is presented in Tables 1, 2 and 3. The samples were collected in 1963-1973 from adults. The greater part of the fungal cultures and the identification of *Geotrichum candidum* strains were done in the fungus laboratory of the Department of Bacteriology and Immunology of the University of Helsinki.

The primary culture of samples was carried out as soon as possible after being taken, on at least the following culture media: malt agar, Mycobiotic agar, Sabouraud agar, Sabouraud broth, and Sabourad-sp-agar (contains penicillin and streptomycin to depress bacterial growth). Primary cultures of a large part of the specimens were made also on Kimmig agar, and many were additionally grown on other media. The specimens were usually cultured without any treatment with the exception that part of each sputum sample was first homogenised with pancreatin and some faeces samples were suspended in physiological saline. Every specimen was cultured both in test tubes and on dishes, and at room temperature, 30° C and 37° C. Pure cultures were prepared of the isolated fungus strains. In the identification of *Geotrichum* strains the information presented especially by MORENZ (1963) and TORHEIM (1963) was used as guidance. Assimilation tests were made of most strains with 28 carbohydrates, in some cases more, in liquid medium (prepared from Bacto-yeast nitrogen base) in which the fungus strains were allowed to grow at room temperature during a minimum of 20 days, but usually for a longer time (KAHANPÄÄ 1972).

Results and discussion

Prevalence of Geotrichum candidum

The basic material of the study presented above (see Table 1), i.e. 839 specimens of bronchial secretion, 156 of lung tissue from patients, 108 of lung tissue taken at autopsy, 186 of pleural effusion, and 6801 of morning sputum (total 8090 specimens) can probably be held to be a very large material considering that already the primary fungal cultures were made on several kinds of culture media. On the basis of these cultures the mean frequency of occurrence of *Geotrichum candidum* in the bronchopulmonary tract of Finnish adults was 1.8 % when the majority of those studied were affected with a mild or severe pulmonary disease. Detailed data on the results of the cultures are presented in Table 1.

In the largest group of patients, those with bronchial asthma, 1971 sputum specimens yielded *Geotrichum candidum* in 2.3 % of

Table 1. *Geotrichum candidum* grown from bronchopulmonary tract specimens. 1963 — 1973.

Specimen group	Patient group	Total number of specimens	Number of positive specimens			Total	Incidence in specimens %
			Scanty growth (+)	Moderate growth (++)	Abundant growth (+++)		
Bronchial secretion	Varia, mostly lung patients	839	1	2	1	4	0.5
Lung tissue	— » —	156	—	2	—	2	1.3
Autopsy specimens of lungs	— » —	108	—	—	—	—	0.0
Pleural effusion	— » —	186	—	—	—	—	0.0
Sputum	Asthma bronchiale	1 971	20	18	8	46	2.3
Sputum	Bronchiectasiae	62	—	—	—	—	0.0
Sputum	Bronchitis chr. cum emphysemate	163	—	2	—	2	1.2
Sputum	Neoplasma malignum pulmonis	50	—	—	2	2	4.0
Sputum	Pneumonia	56	—	—	—	—	0.0
Sputum	Sarcoidosis pulmonum	21	—	—	—	—	0.0
Sputum	Tuberculosis pulmonum	36	—	—	2	2	5.6
Sputum	Varia, mostly lung patients	4 008	33	27	28	88	2.2
Sputum	Hospital lung patients	300	—	—	—	—	0.0
Sputum	Control groups	134	—	—	—	—	0.0
Total		8 090	54	51	41	146	1.8

cases. Information is scant on the possibility that this fungus may act as a respiratory tract allergen. At least one severe case of asthma coincident with bronchopulmonary geotrichosis has been described (ROSS *et al.* 1966). In a fairly recent material of 2404 sputum specimens from France, the detailed composition of which was not stated, *Geotrichum candidum* was present in 1.7 % (BARTHE & BARTHE 1971). It can thus be said that the results of the French and Finnish studies agree quite well. In this connection it should be pointed out that the French investigators used the species designation *Geotrichum matalense*, which may be understood to be a synonym. *Geotrichum candidum* is indeed a good example of the variable nomenclature of fungi in general and particularly in medical mycology: (MORENZ 1963) has listed as many as 90 synonyms applied to this fungus.

The small size of the patient groups with malignant neoplasm of the lung and of pulmonary tuberculosis (Table 1) allow only very cautious conclusions pointing to the probability that *Geotrichum candidum* is slightly more common among these patients than in other subjects. This fits well the theory of the opportunistic nature of the fungus (WEBSTER 1959, CHANG & BUERGER 1964, GHAMANDE *et al.* 1971), even if the isolation of *Geotrichum candidum* from

the bronchopulmonary tract can provide very little more than a hint. From the reports in the literature it would appear that pulmonary tuberculosis is one of the condition-impairing background factors in connection with which *Geotrichum candidum* may be much more often present in the human body and also geotrichosis be more frequent (SAÉZ 1957, MORENZ 1963 and 1971, UTZ 1970). Also in certain skin diseases this fungus has been isolated quite frequently not only from the faeces but also from the respiratory tract. It grew from 8.9 % of 595 sputum samples from patients with skin disease, including some one-hundred patients with psoriasis vulgaris (KRÖNERT 1969).

The frequencies of occurrence in the present study of *Geotrichum candidum* in the specimen groups from the upper respiratory tract and the gastrointestinal tract are seen in Tables 2 and 3.

Although it is known that the frequency of *Geotrichum candidum* in different parts of the body and in various patient groups follows, within certain limits, a fairly regular pattern, the present author has observed in his own material, and has concluded from the literature, that there occasionally may occur even marked variability and peculiar inconsistency in the occurrence of this fungus. Thus in the present study 100 lung patients

Table 2. *Geotrichum candidum* grown from upper respiratory tract specimens. 1963 — 1973.

Specimen group	Patient group	Total number of specimens	Number of positive specimens				Incidence in specimens %
			Scanty growth (+)	Moderate growth (++)	Abundant growth (+++)	Total	
Oral cavity and pharynx	Varia, mostly lung and dental patients	1 283	8	10	17	35	2.7
Mouth rinsing	Control group	134	—	—	2	2	1.5
Nasal cavity and maxillary sinus	Varia, mostly lung patients	78	—	—	—	—	—
	Total	1 495	8	10	19	37	2.5

Table 3. *Geotrichum candidum* grown from gastrointestinal tract specimens. 1963 — 1973.

Specimen group	Patient group	Total number of specimens	Number of positive specimens				Incidence in specimens %
			Scanty growth (+)	Moderate growth (++)	Abundant growth (+++)	Total	
Faeces	Lung patients	84	3	3	11	17	20.2
Faeces	Hospital lung patients	100	2	1	6	9	9.0
Faeces	Various patients	626	25	62	37	124	19.8
Faeces	Control group	134	1	1	3	5	3.7
Gastric juice	Various patients	767	3	11	6	20	2.6
Total		1 711	34	78	63	175	10.2



Figure 1. Some micromorphologic features of a strain of *Geotrichum candidum* isolated from sputum: Filaments (also distinctly visible dichotomous branching) and arthrospores partly with rounded corners. Grown in Sabouraud broth at 37° C for about 1 week. x 500.

consecutively admitted to the ward did not in any of the cases yield *Geotrichum candidum* strains in cultures of sputum although very careful and thorough fungal cultures were carried out three times. Since these patients' sputum yielded an otherwise rich and abundantly growing fungus flora, some *Geotrichum* strain may, however, have become overgrown by other fungi. Also their control groups of 134 persons of good physical condition in relation to their age lacked this fungus in the sputum, whereas it was present in the mouth rinsing in 1.5 % of cases. However, the incidence of *Geotrichum candidum* in the faeces was 9.0 % in the above mentioned group of 100 hospital patients and 3.7 % in the above control group (Table 3).

Comparison of the incidence of *Geotrichum candidum* with the bronchopulmonary occurrence of other microfungi reveals marked, even astonishingly great variations; nevertheless *Geotrichum candidum* usually falls into about the ranking positions 1-12 (COUDERT *et al.* 1957, KIMMEL 1966, BARTHE & BARTHE 1971, PALDROK & KAHANPÄÄ). *Candida albicans*, however, usually is conspicuously in a class of its own (incidence in sputum may be as high as 60-70 %). In the subgroups of 4008 sputum specimens in the present study *Torulopsis glabrata* ranked as second in frequency (incidence 7.9 %) and

Table 4. *Geotrichum candidum* and bronchopulmonary geotrichosis.

<p><i>Geotrichum candidum</i>:</p> <ul style="list-style-type: none"> — yeast-like filamentous fungus — a certain pale fluffiness on the velvety surface of foci — no yeast cells, no budding — filaments break off, forming right-angled, partly more or less rounded arthrospores (Fig. 1) — occasional dichotomous branching of filaments (Fig. 1) — does not produce carbohydrate fermentation — assimilation test in liquid culture media is positive with the following: glucose, galactose, l-sorbose, d-xylose, glycerol and d-mannitol — differential diagnosis must exclude in particular other species of <i>Geotrichum</i>, <i>Coccidioides immitis</i>, and <i>Trichosporon</i> species
<p>Signs pointing to bronchopulmonary geotrichosis:</p> <ul style="list-style-type: none"> — abundant growth of <i>Geotrichum candidum</i> in repeated cultures over long periods from sputum, bronchial secretion, and possibly also gastric juice — abundance of fungus filaments and arthrospores over long periods from fresh preparations of bronchopulmonary samples — chronic, prolonged, inexplicable cough irritation — abundant tenacious, whitish, mucous, often blood-stained expectorations with strong yeast-like odour — indefinite roentgenological appearance of lungs over a long period: bronchitis or showing infiltrates of some kind, and even thin-walled cavities — rise in agglutination titre, positive skin test with <i>Geotrichum</i> antigen (geotrichin test) — physical condition good, unless impaired by primary disease — temperature slightly, if at all, elevated — at least pulmonary tuberculosis, carcinoma of lung and candidosis should be excluded

Aspergillus fumigatus as third, followed closely by *Geotrichum candidum* (2.2 %).

Geotrichum candidum, all of these fungi are capable of producing arthrospores (Fig. 1).

Possibilities of error in the identification of fungi

When identifying *Geotrichum candidum* (Table 4) there must be excluded, with respect to morphological characteristics, not only other species of *Geotrichum* but, e.g., certain species of *Trichosporon* (which are true yeasts), *Gymnoascus*, *Auxarthron* and *Oospora* species, as well as *Coccidioides immitis* which is extremely rare in the Scandinavian countries (WEBSTER 1959, MORENZ 1963 and 1971, TORHEIM 1963, EMMONS 1967, FRÁGNER 1969, ALANKO *et al.* 1975). Like

Importance of fungal cultures

Geotrichum candidum — a microfungus of common occurrence in the respiratory tract and relatively rarely giving rise to mycotic conditions — presents a difficult problem in divining when this fungus may have clinical importance. Conclusions are hardly permissible on the base of isolations from faeces. Its presence in gastric juice appears to correlate fairly well with the bronchopulmonary occurrence. Of essential importance appear to be repeated isolations of the fungus in large

numbers in the course of months and even of years in fungal cultures of sputum and perhaps specifically and concordantly of bronchial secretion (WEBSTER 1959, SYMMERS 1966, ROSS *et al.* 1966). In also the present study *Geotrichum candidum* was less frequently encountered in bronchial secretion than in sputum. In regard to fungi in general, a bronchial finding can be considered much more specific than one from sputum, especially because of less contamination from the upper respiratory tract in the former case (KIMMEL 1966, KAHANPÄÄ 1972). To clarify the total occurrence of *Geotrichum* it is well to take specimens for fungal culture from different parts of the body. Simultaneously with cultures there is reason to examine fresh preparations for fungus particles fitting the description of *Geotrichum candidum*. This fungus often grows also on bacterial culture media. In fact, in bacterial cultures from the respiratory tract *Geotrichum candidum* may be second in frequency (next to *Candida albicans*) of the more abundantly growing fungi (Kahanpää 1972).

Geotrichosis

For establishment of a diagnosis of bronchopulmonary geotrichosis it is of course necessary that there are — in addition to repeated positive results in cultures and fresh

preparations — adequate clinical findings compatible with the disease (Table 4). It is often difficult to detect and confirm these so-called deep-seated mycoses, perhaps in particular the bronchopulmonary ones. It can therefore be assumed that a large proportion of cases of geotrichosis escape recognition. Even if geotrichosis as an independent disease is probably not fatal, it can cause the patient considerable discomfort and be an additional — let us say unnecessary — complication to some primary disease.

The symptoms of bronchopulmonary geotrichosis (Table 4) resemble those of, e.g., pulmonary tuberculosis, as is the case with many other mycoses in this area. Thus haemoptysis may even occur. Roentgenological changes may be visible in the lungs, but there is no specifically typical roentgenological pattern. Serological tests are of possible aid in the diagnosis of geotrichosis, though opinions diverge concerning their value (MORRENZ 1963, BADER 1965, KRÖNERT 1969, WEGMANN 1969).

The prognosis in geotrichosis appears to be good; with improvement in the patient's general physical condition it may even heal spontaneously (WEBSTER 1959, BADER 1965). Medication of various kinds has been used in the treatment of bronchopulmonary geotrichosis. Effective drugs are, at least, iodine, nystatin, natamycin and amphotericin B (DROUHET 1968, WEGMANN 1969, KAHANPÄÄ 1972).

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