

Malassezia skin diseases in humans

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Although *Malassezia* yeasts are a part of the normal microflora, under certain conditions they can cause superficial skin infection, such as pityriasis versicolor (PV) and *Malassezia* folliculitis. Moreover the yeasts of the genus *Malassezia* have been associated with seborrheic dermatitis and dandruff, atopic dermatitis, psoriasis, and, less commonly, with confluent and reticulated papillomatosis, onychomycosis, and transient acantholytic dermatosis. The study of the clinical role of *Malassezia* species has been surrounded by controversy due to the relative difficulty in isolation, cultivation, and identification. This review focuses on the clinical, mycologic, and immunologic aspects of the various skin diseases associated with *Malassezia*. Moreover, since there exists little information about the epidemiology and ecology of *Malassezia* species in the Italian population and the clinical significance of these species is not fully distinguished, we will report data about a study we carried out. The aim of our study was the isolation and the identification of *Malassezia* species in PV-affected skin and non-affected skin in patients with PV and in clinically healthy individuals without any *Malassezia* associated skin disease.

KEY WORDS: *Malassezia* - Tinea versicolor - Dermatitis, seborrheic - Dermatitis, atopic - Psoriasis.

The genus *Malassezia* belongs to the phylum Basidiomycota, class Hymenomycetes, order Tremellales, and family Filobasidiaceae.¹ All *Malassezia* species have distinct morphologic characteristics that allow them to be differentiated from other yeasts. In 1996, Guého *et al.* revised the *Malassezia* genus using morphology, ultrastructure, physiology, and molecular biology, and classified the genus

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into 7 species: *M. globosa*; *M. restricta*; *M. obtusa*; *M. slooffiae*; *M. sympodialis*; *M. furfur*; and *M. pachydermatitis*.² With the development of physiologic and molecular techniques, the genus *Malassezia* was expanded and currently includes 14 species, namely *M. pachydermatitis*, *M. furfur*, *M. sympodialis*, *M. slooffiae*, *M. globosa*, *M. obtusa*, *M. restricta*, *M. dermatitis*, *M. japonica*, *M. nana*, *M. yamatoensis*, *M. equina*, *M. caprae*, and *M. cuniculi*.³ All species are lipid dependent (obligatory lipophilic), except for one non-obligatory lipophilic form, *M. pachydermatitis*, which is primarily zoophilic although it has occasionally been isolated from human skin and has also been implicated in nosocomial systemic infections.^{4, 5}

Yeasts of the genus *Malassezia* are part of the normal human skin flora, and the density of colonization is related to the subject's age and activity of the sebaceous glands in different areas of the body.⁶⁻¹⁰ *M. restricta* seems to be predominant on the scalp skin, whereas *M. sympodialis* predominates on the trunk and *M. globosa* seem to be evenly distributed on both sites. Other species, such as *M. slooffiae* and *M. furfur*, seem to be much less common in healthy human skin.¹⁰⁻¹² However, due to predisposing factors these yeasts become pathogenic and are associ-

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ated with pityriasis versicolor (PV) and *Malassezia* folliculitis.

A large part of pathogenic potential of *Malassezia* is determined by activation of different enzymatic systems. Efficiency of nutrients utilization present on the skin surface and in the sebaceous gland determines simultaneously the density of the *Malassezia* population as well as the quality and quantity of metabolic byproducts. Metabolic byproducts range from irritant or toxicity-free fatty acids to highly bioactive indole derivatives binding to specific cellular receptors regulating the expression of downstream metabolic pathways. The recently reported genome and secretory proteome of *M. globosa* and in part of *M. restricta* provide a molecular basis to understand the adaptations of *Malassezia* yeasts to their environment and to identify pathogenic factors.¹³

The yeasts of the genus *Malassezia* have been associated with a number of other skin diseases, such as seborrheic dermatitis and dandruff, atopic dermatitis, psoriasis, and, less commonly, with confluent and reticulated papillomatosis, onychomycosis, and transient acantholytic dermatosis.^{14, 15} The study of the clinical role of *Malassezia* species has been surrounded by controversy due to the relative difficulty in isolation, cultivation, and identification. Moreover, colonizing the seborrheic areas of the skin, a commensal status of *Malassezia* yeasts cannot be clearly distinguished from the pathogenic stage, with the exception of PV where a transition to the pathogen hyphal form can be found. There is also the clinical question about a relationship between particular *Malassezia* species and the aforementioned disorders, as different authors have debated whether *Malassezia* yeasts are of primary pathogenic significance or a secondary phenomenon.

This review will discuss the skin diseases associated with *Malassezia* yeasts and the evidence for individual specie.

Moreover, since there exists little information about the epidemiology and ecology of *Malassezia* species in the Italian population and the clinical significance of these species is not fully distinguished, we will report data about a study we carried out. The aim of our study was the isolation and the identification of *Malassezia* species in PV-affected skin and non-affected skin in patients with PV and, as control, in clinically healthy individuals without any *Malassezia* associated skin disease.

PV

PV is caused by overgrowth and superficial invasion of human skin by *Malassezia*. While most studies suggest that *M. globosa* is a causative agent of this mycosis, several studies showed that *M. sympodialis* and *M. furfur* were the predominant species.¹⁶⁻²⁴ According to Lyakhovitsky A *et al.*, the higher pathogenicity of *M. globosa* may be a result from its high lipophilic activity.²⁰ The different distribution of *Malassezia* species among several studies may be attributed to the sampling technique and the used culture media. The growth rate and medium requirements substantially vary between *Malassezia* species, which would bias analysis. Colonies of *M. globosa* are the smallest and grow more slowly than other *Malassezia* species. They also seem to be more fragile, not growing at higher temperatures, and in contrast to *M. sympodialis*, they do not survive in Dixon broth for long periods. The difference of findings in distribution of *Malassezia* species is also related to ethnic, climatic, and geographic factors.

The exact pathogenesis of PV has not yet been elucidated. *Malassezia* yeasts is regularly present in its yeast phase on the skin of healthy adults and produces the clinical lesions of PV when developing its hyphal phase. The conditions that induce such transformation remain unclear, although the available data at present indicate that it could be caused by changes in local conditions (*e.g.* heat, humidity, sweat, seborrhea, sebum composition) on an individual/genetic predisposition. The possibility of the existence of particular, more virulent strains of *Malassezia* should also be considered. *Malassezia* yeasts are able to produce *in vitro* reactive oxygen species (ROS) which are supposed to play a role in the pathogenesis of the pigmented variant of PV.²⁵ The hypochromic variant may be explained by toxic effects of lipid peroxides on melanocytes.

M. furfur produces a great variety of pigmented indole derivatives when cultured on a minimal agar medium with tryptophan as sole nitrogen source. Tryptophan aminotransferase (Tam1) was identified as the major enzyme responsible in this biochemical pathway. The role of this enzyme is also underlined by the therapeutic effects of Tam 1 inhibitors such as cycloserine, which may therefore represent a new therapeutic approach to PV. The chemistry and pharmacology of indole derivatives were found to be especially interesting since they might explain differ-

ent symptoms of PV.^{13, 26-30} First these pigments (red substances such as pityriarubins and the yellow substance pityriacitrin) explain the broad spectrum of hyperpigmentation in PV and also the fluorescence which is characteristic for the disease but until now not really understood. The multicolor fluorescence of PV lesions described in the literature (yellow-orange–green-yellow) depends if the indole pigment is dissolved in sweat or epidermal lipids. Moreover pityriacitrin, which absorbs UV radiation, may be accountable for reduced UV sensitivity of the depigmented areas due to its mesomeric structure,²⁷ while lack of inflammation may be caused by the suppressive impact of the pityriarubins on the oxidative burst of human granulocytes.^{28, 29} Interestingly and in contrast to other depigmenting diseases such as vitiligo, hypochromic lesions in PV are less sensitive to UV light. Depigmentations is also caused by others indole derivatives, such as indole A, an inhibitor of tyrosinase, and malassezin, that induces apoptosis in human melanocytes.²⁶ However some authors have invoked in the pathogenesis of depigmentation the role of fungal metabolites with toxic influence on melanocytes, such as dicarboxylic acids, especially azelaic acid, a competitively tyrosinase inhibitor.³¹ Beyond the depigmenting action, malassezin shows the feature of an aryl hydrocarbon receptor (AhR) agonist and induces cytochrome P450 in cultures of rat hepatocytes. *Malassezia* yeasts synthesize other potent ligands of AhR such as indirubin and indolo[3,2-b]carbazole, which inhibit the phenotypic and functional Toll-like receptor-induced maturation of monocyte-derived dendritic cells thus potentially affecting immune surveillance in *Malassezia* associated dermatoses. Moreover, the humoral and cellular immune responses to *Malassezia* yeasts are strongly diminished in patients with PV. The ligands of AhR might act in vivo as immunomodulators in the course of PV, expressing a highly adaptive strategy of *M. furfur* to encounter with the host's defense mechanisms and contributing to the comparably low incidence of inflammatory signs in affected skin lesion.

Etiology of PV: our study

There exists only a little information about the epidemiology and ecology of *Malassezia* species in the Italian healthy subjects and patients with PV. Therefore, the aim of our study was to contribute to the

knowledge of the etiology of PV, by studying clinically healthy individuals without any *Malassezia* associated skin disease and patients with PV, in which the clinically non-affected skin of a seborrheic area of the trunk of the same patients was investigated as control.

Materials

PATIENTS WITH PITYRIASIS VERSICOLOR

The samples were collected from 40 Caucasian subjects from Florence and the surrounding area with PV (21 females and 19 males, age range 16-60 years), who visited our outpatient clinic. Patients with a medical history of autoimmune diseases, diabetes, and immunosuppressive treatment, were excluded. Additional exclusion criteria included any treatment against PV for at least one month before the study. In all cases the clinical diagnosis was confirmed by direct microscopy with KOH 20% of the scales that revealed rounded yeast cells and short, squat hyphae (so-called spaghetti and meatballs) (Figure 1).

Table I shows the main clinical-epidemiologic data of these patients. As we can see, the mycosis was recurrent in 27 patients, and one had 6 relapses in a year. One of the main predisposing factors was hyperhidrosis, and the mycosis was familiar in 6 cases. Clinically, in 18 patients the lesions were typical pink, salmon colored or brownish, whereas in the others the lesions were slightly hypopigmented (Figure 2).

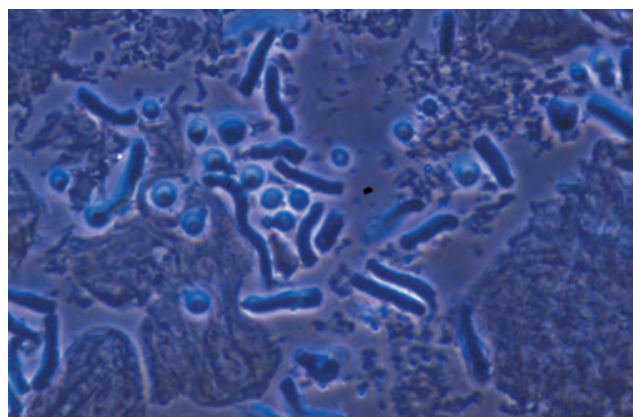


Figure 1.—Direct microscopy (blue cotton stain) of scales of PV: round yeast cells and short hyphae.

TABLE I.—Principal epidemiological data of 40 patients with PV.

	N. cases
1 st episode	13
Relapse	27
Predisposing factors	
Hyperhydrosis	26
Seborrhea	6
Oily skin	2
PV in family members	6
Skin area involved	
Neck	8
Back	13
Pectoral region	14
Abdomen	2
Diffuse	3
Clinical variety	
Hyperchromic	18
Hypochromic	17
Hypo-hyperchromic	5

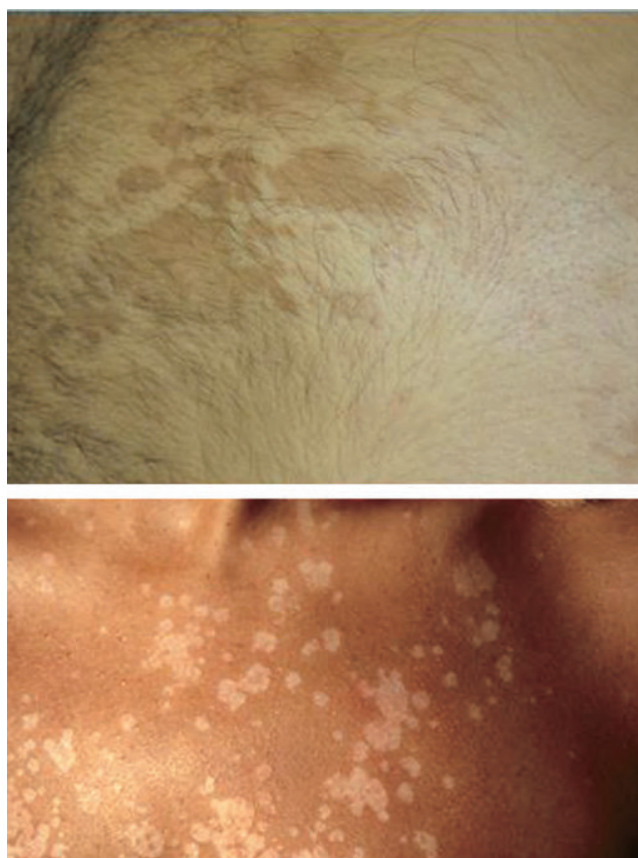


Figure 2.—Hyperchromic and hypochromic lesions of PV.

CLINICALLY HEALTHY INDIVIDUALS

We selected 40 caucasian subjects (12 males and 24 females; age range 16-60 years) from Florence and the surrounding area with negative history for PV and other skin disease *Malassezia* associated.

Methods

COLLECTION OF SCALE SAMPLES

In patients with PV scales were scraped with a sterile blade from lesions and from non-affected skin of the trunk. In control subjects the scales were scraped from the interscapular region. In both groups we scraped a similarly sized areas (approximately 1.5x1.5 cm).

CULTURE TESTS AND IDENTIFICATION OF *MALASSEZIA* SPECIES

The skin samples were immediately incubated on modified Dixon agar for 15 days at 32 °C.³² Species were identified according to their morphological features and the following physiological tests.

Catalase reaction.—The presence of catalase was determined by using a drop of hydrogen peroxide (30% solution) and the production of gas bubbles was considered as a positive reaction. Lack of catalase activity is a characteristic feature of *Malassezia restricta*.³²

Tween assimilation test.—According to the method reported by Guillot *et al.*^{32, 33} ability to utilize different Tween compounds as a unique lipid supplement by *Malassezia* species was evaluated. A yeast suspension (at least 107 cfu/mL) was made in 2 mL sterilized distilled water and poured into plate containing Sabouraud dextrose agar at 45 °C. The inoculums were then spread evenly. After solidification of each plate, four wells were made and filled with 30 µl of a Tween compound, in Tween 20, 40 and 80, respectively. These plates were incubated for a week at 32°C and the growth was assessed around the individual wells after 2, 4 and 7 days (Figure 3).

Splitting of esculin.—The β-glucosidase activity of different *Malassezia* species was assayed.³³ A loop of fresh yeast was inoculated deeply in the esculin agar tube and incubated for 5 days at 32 °C.

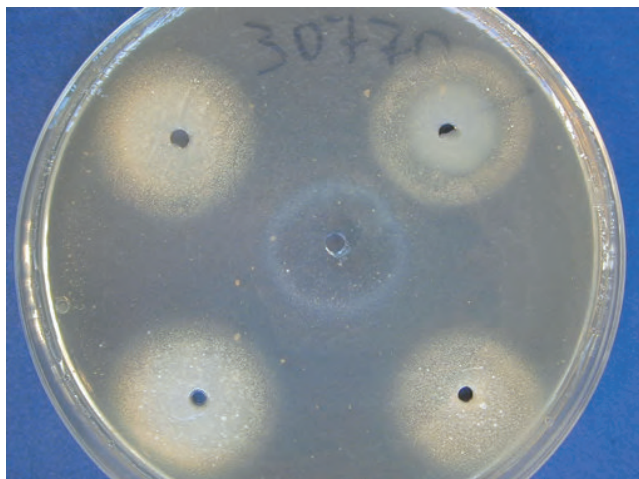


Figure 3.—*M. sympodialis*: tween assimilation test.

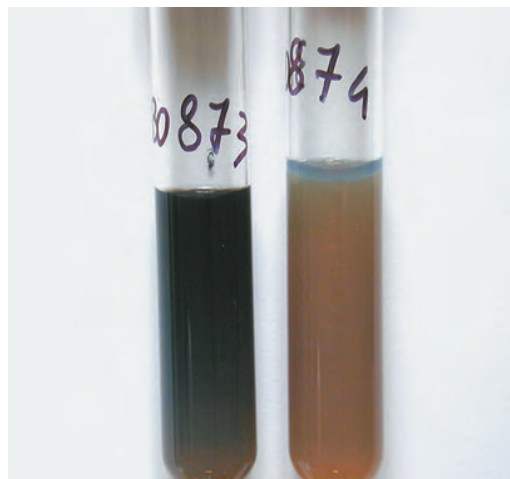


Figure 4.—Splitting of esculin: the test is positive for *M. sympodialis* (left tube; darkening of the medium) and negative for *M. globosa* (right tube).

The splitting of esculin is revealed by darkening of the medium. This test was used to distinguish *M. furfur*, *M. slooffiae* and *M. sympodialis* from other species (Figure 4).

Tryptophane test.—A particular metabolic feature of *Malassezia* yeasts is the synthesis of pigments and fluorochromes when tryptophan is the main nitrogen source. Suspensions of yeast were smeared on agar medium.³⁴ After 14 days (*M. furfur*) and 28 days (*M. pachydermatis*) of incubation, the content of Petri dishes was pureed and extracted with ethyl acetate for 36 h. The extract was filtered over glass wool, evaporated to dryness and dissolved in methanol. The crude extract was separated under UV light (254 nm) by chromatography on Sephadex LH-20 with methanol as eluent. Thin layer chromatography was performed with each fraction on silica gel 60 plates and compared with standards.

Results

PATIENTS WITH PITYRIASIS VERSICOLOR

By culture, *Malassezia* was isolated from PV lesions in 33/40 patients (82.5%). Specifically, as shown in Table II *M. globosa* was isolated in 78.8% of cases: in 13 patients alone and in the other cases in association with *M. sympodialis*. *M. sympodialis* was isolated in other 7 patients. In over half of patients the cultures presented more than 10 colonies (Table III).

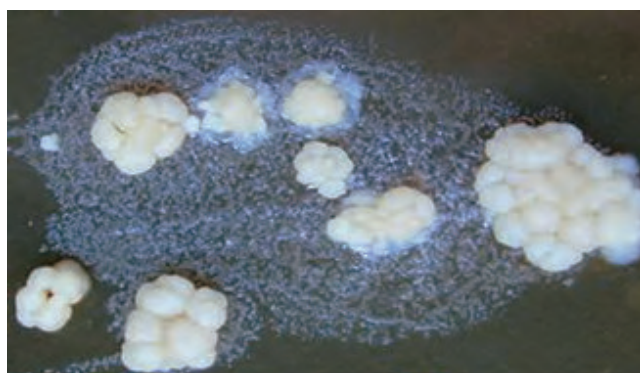
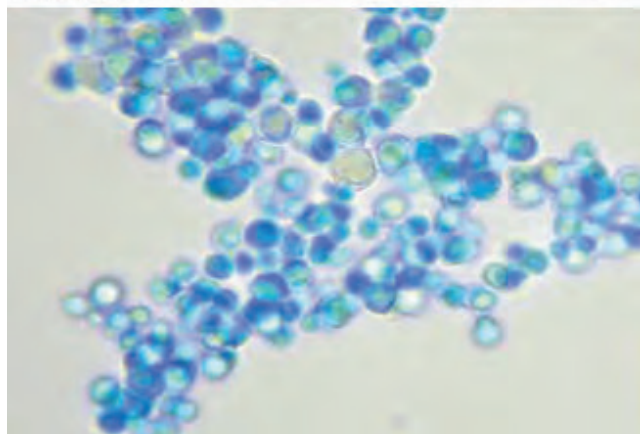
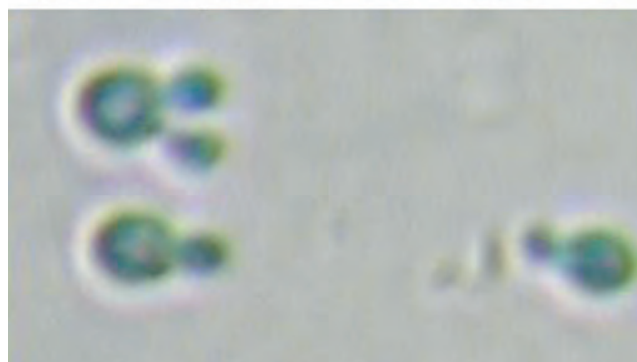
The cultures from non-affected skin revealed growth of *Malassezia* in 15/40 patients (37.5%): *M. globosa* was isolated in 66.7% of cases (in 5 patients alone and in 4 in association with *M. sympodialis*). *M. sympodialis* was isolated in other 5 patients: in 4 cases alone and in the last patient in association with *M. restricta* (Table II). In over half of patients the cultures presented fewer than 10 colonies (Table III).

TABLE II.—*Malassezia* species isolated in patients with PV.

	Lesional skin N. patients (%)	Non-affected skin N. patients (%)
<i>M. globosa</i> (alone)	13 (39.4)	5 (33.3)
<i>M. globosa</i> + <i>M. sympodialis</i>	13 (39.4)	4 (26.7)
<i>M. globosa</i> (total)	26 (78.8)	9 (60)
<i>M. sympodialis</i> (alone)	7 (21.2)	5 (33.3)
<i>M. sympodialis</i> + <i>M. globosa</i>	13 (39.4)	4 (26.7)
<i>M. sympodialis</i> + <i>M. restricta</i>	0	1
<i>M. sympodialis</i> (Total)	20 (60.6)	10 (66.7)

TABLE III.—Number of colonies isolated in patients with PV.

	Lesional skin N. patients (%)	Non-affected skin N. patients (%)
<i>M. globosa</i>		
<10 colonies	8/26 (30.8)	5/9 (55.5)
>10 colonies	18/26 (69.2)	4/9 (44.4)
<i>M. sympodialis</i>		
<10 colonies	9/20 (45)	8/10 (80)
>10 colonies	11/20 (55)	2/10 (20)

Figure 5.—*M. globosa* culture: "fried-egg" colony morphology and round cells with narrow budding base (Parker's blue ink stain).Figure 6.—*M. sympodialis* culture: oval cells with sympodial budding (Parker's blue ink stain).

M. globosa can be identified in most cases by its typical "fried-egg" colony morphology and by the presence of round cells with narrow budding base (Figure 5). The identification was confirmed by the physiological tests (positivity of catalase reaction and negativity of the other tests).

The identification of *M. sympodialis* was suggested by the presence of oval cells with sympodial budding and confirmed by the positivity of catalase reaction, tween assimilation test, splitting

of esculin and by the negativity of triptophane test (Figure 6).

CLINICALLY HEALTHY INDIVIDUALS (CONTROLS)

The culture test was positive in 21 of the 35 subjects (60%). *M. globosa* was isolated in 61.9% of cases (in 7 patients alone and in 6 in association with *M. sympodialis*). *M. sympodialis* was isolated in other 8 patients (Table IV). Approximately in 80% of

TABLE IV.—*Malassezia species isolated in control subjects.*

	N. patients (%)
<i>M. globosa</i> (alone)	7 (33.3)
<i>M. globosa</i> + <i>M. sympodialis</i>	6 (28.6)
<i>M. globosa</i> (total)	13 (61.9)
<i>M. sympodialis</i> (alone)	8 (38.1)
<i>M. sympodialis</i> + <i>M. globosa</i>	6 (28.6)
<i>M. sympodialis</i> (Total)	14 (66.7)

TABLE V.—*Number of colonies isolated in control subjects.*

	No. patients (%)
<i>M. globosa</i>	
<10 colonies	11/13 (84.6)
>10 colonies	2/13 (15.4)
<i>M. sympodialis</i>	
<10 colonies	11/14 (78.6)
>10 colonies	3/14 (21.4)

cases the culture presented less than 10 colonies of either species (Table V).

Conclusions of our study

The culture tests showed growth of *Malassezia* colonies in 82.5% of the patients. The negative responses in the remaining cases can be explained by the presence in the scales of cells with low vitality which adapt poorly to the artificial culture medium. Therefore, we believe that microscope examination is the most sensitive (as well as the simplest and most economical) method for confirming the clinical diagnosis of PV in daily clinical practice.

In this study we isolated *M. globosa* in PV lesions in 78.8% of cases (in 39.4% alone and in 39.4% associated with *M. sympodialis*). We isolated *M. sympodialis* in 60.6% of the cases and specifically, alone in 21.2% and associated with *M. globosa* in 39.4%. Our findings confirm the data reported by other authors in regions with temperate climates such as Spain, Greece and Iran.¹⁷⁻²⁰

M. globosa and *M. sympodialis* were also isolated from non-affected skin in 15 of the 40 PV patients, albeit with a lower number of colonies per culture plate.

In the healthy control group the culture test was positive in 60% of subjects, and allowed us to identify *M. globosa* alone or associated with *M. sympodialis* in 61.9% of the cases and *M. sympodialis* alone or associated with *M. globosa* in 66.7%. Our study shows that *M. globosa* and *M. sympodialis* are the two predominant species. Aside from the isolation of *M. restricta* in just one patient, we did not find any other species such as *M. sloffiae*, which Crespo-Erchiga *et al.* found in Spain, although in a limited number of patients.¹⁸

Concluding, on the basis of our experience, *M. globosa* and *M. sympodialis* (often in association)

are the only two species found on the skin of patients with PV and in healthy subjects. The factors that lead to the transformation into the pathogen hyphal phase and hence clinical lesions remain unclear, although our data also indicate that it could be caused by changes in local conditions (*e.g.* heat, humidity, hyperhidrosis, seborrhea, sebum composition) on an individual/genetic predisposition.

Malassezia folliculitis

Malassezia folliculitis (MF) is an acne-like eruption characteristically located on the "sebaceous" areas of the trunk (shoulders, back, chest). Clinical lesions are small erythematous follicular papules and/or pustules accompanied by intense pruritus. The lesions heal with an easily removable crust. Histological findings demonstrate invasion of the central and deep follicle with large number of yeasts and inflammatory infiltrate consisting of lymphocytes and histiocytes, along with focal rupture of the follicular wall within the destroyed pilosebaceous units.^{15, 35} Most frequently MF affects young oil skinned people with acne vulgaris or seborrheic dermatitis. Its development is favored by hot and humid climates, use of antibiotics, above all tetracyclines, and immunosuppression resulting from leukaemia, lymphomas, AIDS, organ transplantation.^{36, 37} More recently it has been observed in patients receiving anti-tumor necrosis factor (TNF)- α medication (infliximab) for inflammatory bowel disease, erlotinib, for renal carcinoma, and cetuximab for parotid gland adenocarcinoma.³⁸⁻⁴⁰ Due to the many similarities with other forms of folliculitis and the fact that *Malassezia* yeasts are not routinely cultured, this condition might be underdiagnosed in the daily practice. *M. pachydermatis*, *M. globosa* and *M. furfur* are the predominant causative agents.³⁷

Seborrheic dermatitis

Seborrheic dermatitis (SD) is a chronic, widespread skin condition, which is considered a multifactorial disease influenced, in part, by *Malassezia* spp. opportunistic activities, as well as various endogenous and exogenous factors. Pityriasis simplex capitis (so-called "dandruff") is a mild form of scalp SD. The isolation of *Malassezia* species from dandruff and SD lesions varies around the world and the study of the relationship among factors such as gender, age, immunosuppressive condition of the patient and SD development and can lead to a better understanding of this disease. Some authors have stated that *M. globosa* predominate, whilst others have found *M. restricta* or *M. sympodialis* to be the most common species in lesion of SD.⁴¹⁻⁴⁸ The pathogenesis and exact mechanisms via which these yeasts cause inflammation are still not fully elucidated. They are rather complex and subject of controversy in literature.⁴⁹⁻⁵¹ Most probably *Malassezia* spp. cause seborrheic dermatitis by involving and combining both non-immune and immune mechanisms (nonspecific and specific). Which of these mechanisms will dominate in any single case depends on the number and virulence of the yeasts as well as on the microorganism reactivity. A direct causal link between *Malassezia* yeast and SD has been proposed based on the distribution of *Malassezia* species on the skin of lipid-rich anatomic locations, such as the face, scalp, and trunk, on the presence of an increased number of *Malassezia* cells in affected SD skin compared with SD-free individuals, and on the therapeutic response seen to antifungal agents. Improvement in SD is accompanied by reduction in the yeast on the scalp, whereas recolonization leads to disease recurrence. SD is not associated with microscopic changes of the fungus morphology, and it remains unclear whether SD patients have or not higher *Malassezia* counts than normal controls, although a correlation between yeast density and severity of SD has been reported. It was proposed that lipases may be related to the development of SD and could be considered as virulence factors. Some authors suggest that these enzymes provide the ability to metabolize lipids and to integrate the fatty acids into the fungal cell wall, and thus are very important for growth.⁵⁵ The current hypothesis for SD/dandruff pathogenesis associates individual susceptibility with the penetration of irritating *Malassezia*

metabolites, such as oleic acid, through a defective epidermal barrier.⁵⁶ *M. globosa* produces oleic acid through lipase activity, and the desquamation seen on dandruff skin can be caused by oleic acid, in dandruff-susceptible individuals. Malassezin and indole-3-carbaldehyde, both produced on the skin of patients with *Malassezia* associated SD, have been implicated in immunologic events such as the differentiation of Th17 cells and the production of inflammation and mediation of contact sensitivity in transgenic mice. It was found that compared with healthy controls bioactive indoles that are AhR agonists are selectively produced by *M. furfur* isolates from SD patients.⁵⁷ In SD, the lipophilic malassezin and the indolo[3,2-b]carbazole could cross the defective epidermis, reach the granular and spinous layers, and activate the AhR. Subsequent downregulation of the high-affinity epidermal growth factor receptor could trigger SD.

Atopic dermatitis

Despite intense research over the past few decades, the pathogenesis of atopic dermatitis (AD) is still not fully understood. A number of exogenous and endogenous trigger factors have been identified. Gene-environment interactions in genetically predisposed subjects also appear to play a central role. Furthermore, there is evidence for a dysregulation of the cellular and humoral immune response and for defects of skin barrier function in patients with AD. Microorganisms, in particular *Staphylococcus aureus* and *Malassezia* yeasts have been described as contributing to the disease pathogenesis.⁵⁸⁻⁶⁷ *M. sympodialis* has been reported as the most frequent species in patients with AD, both *M. restricta* and *M. globosa* are thought to play significant roles. Approximately 50% of adults with AD show immediate-type skin reactions and/or have specific serum IgE antibodies against *M. sympodialis*. Sensitization to this yeast occurs almost exclusively in patients with AD. A significant correlation has been reported between the level of these IgE antibodies and the clinical severity in head and neck AD. Recently, autoreactivity to human proteins has been postulated as a pathogenic mechanism for AD. Specifically Balaji *et al.*⁶⁸ documented cross-reactivity at the T-cell level between *M. sympodialis* thioredoxin (Mals 13) and its human homologue (h Trx). These data

indicate that autoreactive T cells are characterized by a cytokine secretion profile encompassing not only the Th1 and Th2 phenotypes but also the Th17 and Th22 phenotypes, which might have relevance in the pathogenesis of AD.

Psoriasis

Reports of efficacy of antifungal drugs in the treatment of scalp psoriasis have suggested a pathogenic role of *Malassezia* species.^{69, 70} Currently only a secondary role, at most of an exacerbating factor, can be supported for *Malassezia*.⁷¹⁻⁷³ *M. restricta* is predominant in patients with psoriasis, in contrast to those with PV.⁷² It was suggested that this predominance is caused by the different lipid classes in psoriasis, specifically by a significant increase in ceramides in diseased skin and in cholesterol and squalene. The possible mechanisms by which these organisms may trigger psoriatic lesions have, however, yet to be elucidated. Studies have demonstrated that *Malassezia* can induce the overproduction of molecules involved in cell migration and hyperproliferation, thereby favoring the exacerbation of psoriasis.

Riassunto

Dermatosi umane associate alla malassezia

I lieviti del genere *Malassezia* fanno parte della comune flora saprofitica e in particolari condizioni possono causare infezioni superficiali quali la pitiriasi versicolore e una particolare forma di follicolite. Un loro ruolo, inoltre, viene discusso in alcune affezioni quali la dermatite seborroica, la pitiriasi simplex del cuoio capelluto, la dermatite atopica e la psoriasi. Più raramente questi lieviti sono stati associati alla papillomatosi confluyente e reticolare, ad onicomicosi e alla dermatosi acantolitica transiente. Lo studio del ruolo della *Malassezia* è comunque oggetto di controversie, anche in conseguenza delle relative difficoltà di crescita su terreni di coltura e di identificazione di specie. In questo lavoro puntualizzeremo gli aspetti clinici, epidemiologici e immunologici delle dermatosi associate alla *Malassezia*. Inoltre, dal momento che i dati sulla epidemiologia e sul significato clinico di questi miceti nella popolazione italiana sono estremamente carenti, riporteremo i risultati di uno studio da noi condotto nella pitiriasi versicolore. Lo scopo di questo studio era l'isolamento e l'identificazione delle specie di *Malassezia* nei pazienti con pitiriasi versicolore su prelievi eseguiti a livello di lesione e a livello di una zona seborroica non lesionale. Per controllo abbiamo scel-

to prelievi eseguiti a livello del tronco da soggetti clinicamente sani, senza anamnesi positiva per affezioni correlate alla *Malassezia*.

PAROLE CHIAVE: Malassezia - Tinea versicolor - Dermatite seborroica - Dermatite atopica - Psoriasi.

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