GENERIC RANKS IN THE MYCOTORULAE[1]

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In a paper by the author (1[a]) it was demonstrated that medical mycology has such a wide range of interpretations for what constitutes its Monilia-concept that, in the light of our knowledge of the group of asporogenous fungi which doctors of medicine call by this genus name, it is possible to separate these organisms into as many as twenty distinct and widely unrelated genera. Since the publication of Berkhout's thesis (2), in which she calls attention to the morphological and physiological differences in some of the medical Monilias, many papers have appeared, and new facts have been discovered regarding the group.

The most recent paper on the subject is that of Langeron and Talice (3[a]). The authors present a new classification and arrangement of the previous classification of Ciferri and Redaelli (4[a]). This last work has been also revised by its authors (4[b]). A comparison of the two revisions will help to elucidate some of the facts regarding the validity of the genera discussed and their relative position in their classification. While Ciferri and Redaelli include the genera *Blastodendrion* Ota, *Geotrichum* Link, *Pseudomycoderma* Will, *Pseudomonilia* Geiger, *Candida* Berkhout, *Mycotorula* Will and *Enantiothamnus* Pinoy; Langeron and Talice do not recognize the genera *Pseudomycoderma* and *Pseudomonilia,* make *Enantiothamnus* a synonym of *Mycotorula,* and propose the following new genera, *Mycotoruloides, Mycocandida* and *Geotrichoides.* In many instances the type species are changed to conform with the new genus-concept presented. The validity of these changes will be discussed later.

The subfamily MYCOTORULAE Ciferri is characterized by saccharomycetous forms which never produce conidia and whose blastospores are encountered mixed with the mycelial hyphae. Other physiological characters also differentiate the group. The type-genus of the subfamily is *Mycotorula* Will.

A discussion of this genus as interpreted by Langeron and Talice and by Ciferri and Redaelli will show that we are too far from a uniformity of concepts in this group of organisms.

Mycotorula Will(5) was amended by Ciferri(6) as follows:

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[1] Contribution from the Department of Biology, University of Puerto Rico, No. 3.

"Cellulae ovales saepe oblungate, mycelium septatum ramosum, rare cum gemmatione non aut breve catelunata, rarius cum pseudomycelio continuo. Endosporae carentes. Vegetatio superficialis et coloniae gigantes plicatae et crateriformes". Though no type species is designated by Will, the first one described, according to the accepted rules of nomenclature, should be considered as such. For this reason, Ciferri and Redaelli (4[c]) selected *Mycotorula craterica* Will, as the type, since it conforms more closely with the description of the genus. Langeron and Talice on the other hand (3[a] p. 43) also amend the characters of the genus and give quite a different concept, designating another type species: *Mycotorula albicans* (Robin) Langeron and Talice.

A discussion of the facts regarding this last mentioned species will reveal the nonvalidity of their *Mycotorula* concept. This fungus was first described as *Oidium albicans* by Robin(7). Later, Zopf(8) transferred the species to *Monilia albicans*. In his studies with the organism which causes thrush in human beings, Vuillemin (9), working with the species *Oidium albicans,* in the sense of Robin, found ascospores, and on the strength of these structures, renamed the species, *Endomyces albicans* (Robin) Vuillemin. According to the established rules of nomenclature (and medical mycologists are bound to conform with them) if the perfect stage of an imperfect form is encountered, the fungus takes the former name and the latter is no longer valid. *Endomyces* Rees is a genus of the Gymnascales, an order of the lower Ascomycetes, and *Oidium albicans* Robin, therefore, becomes a *nomen nudum.*

The *Mycotorula*-concept of Langeron and Talice (3[b]) is further complicated when they include *Enantiothamnus* Pinoy as a synonym of *Mycotorula* Will. As defined by its author, the former genus differs from the latter in the fact that the budding cellules are normally spaced on the sides of septate mycelial hyphae. This character leads Archibald and Chalmers (10) to establish a new family, ENANTIOTHAMNACEAE, for its inclusion. Here again, we have another instance of disregard for the rules of nomenclature. *Enantiothamnus* Pinoy antedates *Mycotorula* Will by five years. If they are synonymous, as the authors suggest, the genus should bear the former name, for reason of priority. But still more confusion is caused in respect to this matter when Langeron and

Talice include the only species of *Enantiothamnus, E. braulti* Pinoy, as a probable synonym for *Blastodendrion* Ota, thus suggesting that the three genera are co-specific. *Blastodendrion* Ota is a transitional genus between the TORULOPSIDEAE and MYCOTORULEAE and differs from *Mycotorula* Will in the complete absence of true mycelial elements.

For the reasons just mentioned we propose that the *Mycotorula*-type of Langeron and Talice, *Endomyces albicans* (Robin) Vuillemin be discarded and that the first described species of Will, *Mycotorula craterica,* be reinstated as the type. Also that *Enantiothamnus* Pinoy be considered as a separate genus until more complete data of its species *E. braulti* Pinoy, is obtained.

The criterion for the establishment of the new genus *Mycotoruloides* Langeron and Talice is the behavior of the species on culture media, where the fungus shows that "Le type normal peut subir toute une serie de modifications dont la premiére est une complication des verticilles qui, au lieu de rester simples devienent ramifiés et composés: ce sera le nouveau genre *Mycotoruloides*". That fungi are very variable as to form and cultural characteristics has been repeatedly demonstrated in the various works on physiologic races, strains and saltants. The author (1[b]) differentiated eleven strains of *Gloeosporium musarum* Cooke and Massee on the basis of their behavior in culture media. All these strains departed from the original in the amount of aerial mycelium, rate of growth, zonation, color, type of sporulation and, in some cases, type and shape of the spores. Yet they were all derived from a single monospore culture. In their studies on the TORULOPSIDACEAE, Ciferri and Redaelli(4[a]) found that this group of fungi have such a wide range of variability in culture that it is impossible to obtain the same form of growth and morphology in different transfers of the same media. Moreover, "Experiments made by one of us and not as yet published, show that a given medium may have notable influence on the biological activities of a species, ..." Butler (11) commenting on the importance of physiology on the delimitation of species points out that "It is largely a question of being able to use particular nutrient materials or of being able to alter substances by enzyme action so that they may be assimilated or at least neutralized. It appears to be extremely doubtful if any more weight should be attached

to host specialization in the parasites than to cultural characters in the saprophytes, and if we refuse to accept the one in classification it is difficult to justify the use of the other".

The delimitation of species on cultural characters is a difficult task. Much more unreliable is the recognition of genera on this basis. Two different points of view are in vogue among taxonomists as to what constitutes a genus. Some believe that a genus is an objective entity made up by a group of species differing from other groups of species by certain distinctive and fixed morphological characters. Others, however, state that it is a mental concept. If we accept the first definition and consider the amount of variations to which a species is subjected in culture media we are forced to discard *Mycotoruloides* Langeron and Talice and consider its type species as a modified *Mycotorula*. On the other hand, if the second definition is followed, the genus will also be a *Mycotorula* since one can hardly differentiate between their figures for *Mycotorula albicans* (Pl. I, Fig. 3.) and *Mycotoruloides ovalis* (Pl. 2, Fig. 3.)

Mycocandida is another of the new genera proposed by Langeron and Talice. The distinctive character is the ratio of mycelial branches to blastospores. This character is very insufficient, since the abundance or scarcity of mycelium is no criterion for differentiation among genera. Moreover, their concept of this genus is the same as that of Berkhout (2) for her genus *Candida*. On the other hand, *Candida,* in the sense of Langeron and Talice (4[c]) is a *Redaellia* Ciferri.

Geotrichoides resembles *Proteomyces* Moses et Viana (12) and until further studies are made we propose that they be considered the same. The figures given by Langeron and Talice show clearly the two types of blastospores and mycelial hyphae, although no mention of them is made in the description.

This brings us to a discussion of the genera that are to be included in the Mycotorulae. Of the total number of genera already described, only nine can be definitely identified on their morphological characteristics. In view of our limited knowledge of the group and for the sake of conservatism and caution, we are regarding the other genera as imperfectly known forms with no systematic standing. The following key attempts to bring out the morphological differences of the genera.

KEY TO GENERA OF THE MYCOTORULAE

Cells normally of two types, one saccharomycetous, the other elongated, forming pseudo-mycelium and true mycelium; Subfam. MYCOTORULEAE Ciferri.

I. Mycelial hyphae of two types, septate and aseptate, resulting from the germination of two sorts of arthrospores . . . . . Gen. 1. *Proteomyces* Moses and Viana.

II. Either mycelial or pseudo-hyphae produced and these of only one kind.

A. Only pseudo-hyphae present.

1. Cells aggregated in a crown. . . . Gen. 2. *Blastodendrion* Ota.

B. True mycelial hyphae present.

1. Crowns of blastospores not clearly distinct.

a. Cells rectangular with rounded ends. . . . . Gen. 3. *Geotrichum* Link.

b. Cells filiform. . . . . Gen. 4. *Pseudomycoderma* Will.

2. Blastospores not forming crowns.

1. Hyphae continuous. . . . . Gen. 5. *Pseudomonilia* Geiger.

2. Hyphae septate.

a. Blastospores catenulate.

1. Cells long inserted at the apex of hyphae. . . . . Gen. 6. *Candida* Berk.

2. Cells verticillate at the apex of hyphae. . . . . Gen. 7. *Redaellia* Ciferri.

b. Blastospores acrogenous or pleurogenous, not catenulate.

1. Cells irregularly spaced along hyphae. . . . . Gen. 8. *Mycotorula* Will.

2. Cells regularly spaced, always pleurogenous. . . . . Gen. 9. *Enantiothamnus* Pinoy.

The above classification is of necessity too artificial. If

we consider the absence of a sexual reproduction in the group and the great variability in morphology and physiology induced by differences in substrates among the fungi, we must admit that long and continuous studies are necessary in order to discover the phylogenetic relationships of the group. Not until these are discovered can we produce conclusive evidence as to the proper position in classification and validity of the genera now considered under the Mycotorulae.

REFERENCES

1. **Toro, R. A.** *a.* 1930. Rev. Med. Quir. Hosp. Bogotá. 191.
   b. 1922. Jour. Dept. Agric. Puerto Rico. VI: 11.
2. **Berkhout, C.** 1923. De Schimmelgeslachten *Monilia, Oidium, Oospora* en *Torula*. 72.
3. **Langeron and Talice.** *a.* 1932. Ann. de Paras. Hum. et Comp. X: 1–80.
   b. 1911. Ann. de Dermat. & Syph. 599.
   c. 1930. Arch. f. Prot. LXXI: 428.
4. **Ciferri and Redaelli.** *a.* 1925. Atti. R. 1st Bot. Univ. Pavia. 147–292.
   b. 1929. Ann. Myc. XXVII: 243–295.
   c. 1929. Ann. Myc. XXVII: 283.
   d. 1929. Zent. f. Bakt. Parasit. u. Infkrankh. LXXVIII²: 243.
5. **Will, H.** 1916. Cent. f. Bakt. CLXII: 272.
6. **Ciferri, R.** 1925 Atti. 1st R. Bot. Univ. Pavia. 193.
7. **Robin, C.** 1853. Hist. Nat. Veg. Paras. Paris.
8. **Zopf, W.** 1890. Die Pilze, Breslau. 29.
9. **Vuillemin, P.** 1899. Rev. Mycol. XXI: 43.
10. **Archibald and Chalmers.** 1919. Castellani and Chalmers Man. Trop. Med.
11. **Butler, E.** 1929. Proc. Int. Cong. Pl. Sc. II: 1593.
12. **Moses and Viana.** 1913. Mem. Ins. Oswaldo Cruz. V: 192.