

## الفطريات الجلدية في الحيوانات والطيور والإنسان

الجزء الأول : الحيوانات كمصدر لنقل عدوى الفطريات الجلدية للإنسان

ي . ي . كامل ، م . م . أحمد ، أ . أ . اسماعيل

### الملخص العربي

تم فحص عدد ٤٩٦ عينة شعر من حيوانات سليمة مظهرها من أماكن مختلفة بمدينة أسيوط للاستدلال على وجود الفطريات المسببة للأمراض وقد وجد أن ٣٧ عينة بنسبة ٧.٤٦٪ بها فطريات .

وقد نوقشت احتمالات العدوى للإنسان بواسطة الفطريات المشتركة بين الإنسان والحيوان .

ՀԱՅՏՏՆԱԿԱՆ ԲՈՒՄԱՆԱԿԱՆ ԿՈՄՊԵՆԻԱ ՍՊԵՏ

ՀԱՅՏՏՆԱԿԱՆ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ : ՀԱՅՏՏՆԱԿԱՆ

ՎԵՍՏԻՍՏԱՆԻ ԿՈՄՊԵՆԻԱ ՍՊԵՏ : ԿՈՄՊԵՆԻԱ ՍՊԵՏ

ԿՈՄՊԵՆԻԱ ՍՊԵՏ

ՀԱՅՏՏՆԱԿԱՆ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ  
ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ  
ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ

ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ ԿՈՄՊԵՆԻԱ ՍՊԵՏ

**DERMATOPHYTES IN ANIMALS, BIRDS AND MAN PART I.  
ANIMALS AS POTENTIAL PRESERVOIR OF  
DERMATOPHYTES TO MAN**

(With 3 tables)

By

**Y.Y. Kamel, M.A. Ahmed\* and A.A. Ismail**

(Recieved at 6/9/1976)

**SUMMARY**

A total of 496 hair samples were collected from different species of apparently healthy animals in different localities in Assiut City. Every sample was mycologically examined for the presence of pathogenic fungi.

These investigation revealed that 37(7.46%) of the examined specimens were culturallly positive. Out of the isolated strains 6 (1.21%) were identified as *Microsporium canis*, 1(0.2%) *Trichophyton verrucosum*, 1 (0.2%) *Trichophyton equinum*, 12(2.42%) *Trichophyton mentagrophytes*, 10 (2.02%) *Microsporium gypseum*, 2 (0.4%) *Keratinomyces ajello*, and 5 (1.01%) *Trichophyton terrestre*. The possible trends leading to human infection with zoophilic fungi have been discussed.

**INTRODUCTION**

Dermatomycosis is an integumentary group of diseases affecting the most superficial parts of the body and is caused by fungi belonging to a group referred to as dermatophytes. These organisms that may affect both animals and man were first recognized and reported by GRUBY, 1843 ; SABOURAUD, 1894 ; BODIN, 1896 ; and MATRUCHOT & DASSONVILLE, 1898.

Regarding the preferential habitat of the dermatophytes, the organisms are classified as geophilic or Keratinophilic. Further classification of the dermatophytes has been made on the basis of preference of the organisms for human or animals tissues into anthropophilic or zoophilic. The zoophilic fungi are primary the pathogens of animals. Many of these organisms have a special affinities but not limitations. Under this group, *Microsporium canis*; *Microsporium distortum*, *Trichophyton gallinae*, *Trichophyton verrucosum* and *Trichophyton equinum* are of considerable importance in human ringworm.

\* Lecturer of Mycology, Faculty of Medicine, Assiut University.

The usual routes of human infection with zoophilic fungi are either by direct contact of susceptible individuals with infected animals or indirect through contaminated premises and fomites. Most cases of animals ringworm usually involve the patient only and spare the family member. However, zoophilic dermatophytes may cause human epidemic (BLANK, 1955). Moreover CHEMEL and VALENTOVA (1956) reported the occurrence of human infection with zoophilic dermatophytes in 90.3 percent of 3066 patients with ringworm. SMITH *et al* (1969) in a survey for the determination of the role played by zoophilic fungi in the epidemiology of human ringworm, were able to isolate 1579 dermatophytes of animal origin from human lesions.

During recent years it has found that the clinically healthy animals may harbour certain pathogenic fungi on their skin and hairs. Therefore, there are an increasing indication that these asymptomatic animal carriers may play a role in transmitting these agents to man. BOHN *et al* (1969) succeeded in isolating *Trichophyton mentagrophytes* var. *granulosum* from 5 (4.9%) out of 103 healthy skin chinchilla rabbits. In 1907, STEPANOVA and DAVYDOV reported the presence of *Microsporum canis* in 5 of 206 samples of nonfluorescent hair from clinically healthy cats. Also SCHEKLAKOW *et al* (1972) isolated 5 strains of *Microsporum canis* from 206 clinically healthy cats. BAXTER (1973) mentioned that *Microsporum canis* was present in 3.7 percent of 200 cats and 1.3 percent of 120 dogs. Many of these animals were considered as symptomless carriers. In the same year, EL-BAHAY and REFAI reported the isolation of 5 strains of *Microsporum canis* from examined hairs collected from 113 clinically healthy dogs. In 1974, PASCOE and CNONOLE succeeded in isolating *Microsporum gypseum* from an apparently normal stallion.

As the significance of the asymptomatic animal carriers which can act as potential sources of dermatophytes to human beings has not been fully assessed, the authors had made an attempt in the present work to find out the role played by these animals in transmitting these pathogenic agents to man.

#### MATERIAL AND METHOD

Hair samples were collected from 496 different species of apparently healthy animals and from different localities in and around Assiut City. Each sample was obtained from the hair found on the different parts of the body of each animal including head, neck, back, abdomen, thigh and tail. The collected specimen was transferred to the laboratory in a sterile cellophane bag for mycological examination.

In the laboratory the technique described by Vanbreuseghem (1952) was applied. Sterile Petri-dishes half filled with sterile soil were prepared. The sterile soil was thoroughly moisten with sufficient amount of sterile water. Thereafter, every hair sample was distributed over the surface of the moistened soil and incubated at room temperature (20-25°). The incubated plates were examined weekly for a period of three months and those pieces of hair that become covered with mycelium were examined as follows :

Cultures were made from these detected growth by bait technique on modified Sabouraud's dextrose agar medium of MOSS & McQuown (1969) containing sodium penicillin, dihydrostreptomycin & cyclohexamide (actidione) in a concentration of 20 i.u. / ml, 40 mg/ml & 0.05% respectively. The inoculated media were incubated at room temperature for 4 weeks. Reproduced fungal growth on this medium was identified as follows :

1. Colonial characteristics including colour, elevation, margin, configuration, consistency and detachability from the surface of the agar medium were recorded.

2. The slide culture method of RIDDELL (1950) was used for studying the nature of the microscopic structures of the isolated fungi.

### RESULTS

The results obtained are recorded in table 1-3

TABLE 1.—Number and percentage distribution of positive and negative specimens.

Animal	No. of	Culture			
		Positive (pathogenic)		Negative	
	Samples	No.	%	No.	%
Camel . . . . .	28	1	3.57	27	96.43
Cattle . . . . .	69	4	5.80	65	94.20
Buffaloe . . . . .	53	3	5.66	50	94.34
Sheep . . . . .	47	3	6.38	44	93.62
Goat . . . . .	34	1	2.94	33	97.06
Horse . . . . .	36	2	5.56	34	94.44
Donkey . . . . .	65	4	6.15	61	93.85
Pig . . . . .	57	6	10.53	51	89.47
Dog . . . . .	96	11	11.46	85	88.54
Cat . . . . .	11	2	18.18	9	81.82
Total . . . . .	496	37	7.46	459	92.54

TABLE II.—Incidence and percentage distribution of isolates

Species of animals	Number of Specimens	Number of Isolates	Type of isolates														
			M. Canis		T. verrucosum		T. equinum		T. mentagrophytes		M. gypsum		K. ujello		T. terrestre		
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Camel . . . . .	28	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cattle . . . . .	69	4	—	1	1.45	—	—	2	2.90	—	—	—	—	—	1	1.45	—
Buffaloe . . . . .	53	3	—	—	—	—	—	3	5.66	—	—	—	—	—	—	—	—
Sheep . . . . .	47	3	—	—	—	—	—	—	—	—	—	—	—	—	2	4.26	—
Goat . . . . .	34	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Horse . . . . .	36	2	—	—	—	—	—	1	2.78	—	—	—	—	—	—	—	1
Donkey . . . . .	65	4	—	—	—	—	—	—	—	—	—	—	—	—	3	4.62	—
Pig . . . . .	57	6	1	1.75	—	—	—	4	7.02	—	—	—	—	—	1	1.75	—
Dog . . . . .	96	11	4	4.17	—	—	—	2	2.08	—	—	—	—	—	3	3.13	—
Cat . . . . .	11	2	1	9.1	—	—	—	—	—	—	—	—	—	—	—	—	1
Total . . . . .	496	37	6	1.21	1	0.20	1	0.20	12	2.42	10	2.02	2	0.40	5	1.01	—

TABLE III.—Incidence and percentage distribution of different types of Zoophilic and Geophilic fungi isolated from different species of animals

Animals	No of Specimens	Type of isolates													
		Isolates		Zoophilic fungi				Geophilic fungi							
		No.	%	M. Canis	T. verrucosum	T. equinum	T. mentagrophytes	M. gypsum	K. ajello	T. terrestre					
Ruminants . . .	231	12	5.19	—	1	0.43	—	5	2.16	3	1.20	2	0.86	1	0.43
Equine . . . . .	101	6	5.94	—	—	0.99	1	0.99	1	0.99	3	2.97	—	1	0.99
Swine . . . . .	57	6	10.53	1	1.75	—	—	4	7.02	1	1.75	—	—	—	—
Canine & Feline (Dogs & Cats) . .	107	13	12.15	5	4.67	—	—	2	1.87	3	2.80	—	—	3	2.80

## DISCUSSION

In this study, 496 hair samples were collected from different species of clinically healthy animals and examined mycologically for dermatophytes.

A total of 37 dermatophytes (7.46%) were isolated from the different species of animals. As shown in Table 1, the most predominant animal of higher incidence detected was the cat (18.18%) followed by other animals in the following order of frequency : dog (11.46%), Pig (10.53%), sheep (6.38%), donkey (6.15%), cattle (5.8%), buffaloe (5.66%), horse (5.56%) camel (3.57%) and goat (2.94%).

The frequency of the isolated strains in the different species of ruminant animals were tabulated in Table 11 & 111. Twelve strains (5.19%) were recovered from these animals of which *Trichophyton verrucosum* was 1 (0.43%), followed by other dermatophytes as *Trichophyton mentagrophytes* 5 (2.16%), *Microsporum gypseum* 3 (1.2%), *Keratinomyces ajello* 2 (0.88%) and *Trichophyton terrestre* 1 (0.43%).

Six strains (5.94) were isolated from equines and consisted of one (0.99%) of each *Trichophyton equinum*, *Trichophyton mentagrophytes* & *Trichophyton terrestre* and 3 (2.97%) *Microsporum gypseum*.

A total of six strains (10.35%) were recovered from pigs. These strains were compared of 1 (1.75%) of each *Microsporum canis* & *Microsporum gypseum* and 4 (7.02%) *Trichophyton mentagrophytes*.

A sum of 13 strains (12.15%) were isolated from dogs and cats, 5 (4.67%) of which were *Microsporum canis*, 3 (2.8%) *Microsporum gypseum*, 3 (2.8%) *Trichophyton terrestre*, and 2 (1.87%) were *Trichophyton mentagrophytes*.

The total number of zoophilic dermatophytes isolated were 8 (1.61%) and their distribution was as follows ; 6 (1.21%) *Microsporum canis* and 1 (0.2%) of each *Trichophyton verrucosum* & *Trichophyton equinum*. 12 (2.42%) strains were *Trichophyton mentagrophytes*, these dermatophytes cannot be classified as either zoophilic or anthropophilic as they may affected both animals and man (GEORG, 1960).

Concerning the distribution of the different zoophilic dermatophytes isolated from the different species of apparently healthy animals, it was found that the results obtained were in accordance with the findings of other investigators who succeeded in isolating *Microsporum canis* from dogs and cats as STEPANORA *et al.*, 1970; SCHEKLAKOW *et al.*, 1972; BAXTER 1973; & EL-BAHAY *et al.*, 1973. The percentage of *Microsporum canis* obtained (4.67) is quite similar to that isolated from dogs and cats in the work done by those workers.

From the epidemiological point of view, the isolation of *Microsporum canis* from cats (9.1%), dogs (4.17%) and pigs (1.75%) is of great hazardous. This dermatophyte has been responsible for many cases of ringworm in man especially the children where it is detected more frequently (ALIEVA *et al.*,



1974). However, the infection with *microsporum canis* is generally estimated by 14.5 percent of all dermatophytes isolated from human lesions (BADILLET, 1973), and the usual route of infection is mostly acquired by direct contact with dogs and cats (BLANK, 1955 & KAPLAN *et al*, 1958).

*Trichophyton verrucosum* was isolated only from one of the 69 examined cows representing (1.45%). This organism is considered as one of the most important pathogenic fungi affecting human being as a cause of ringworm. In one series of patients affected with dermatomycosis. GEORG *et al* (1956) found that *Trichophyton verrucosum* caused approximately half the cases of ring worm in rural districts. Most of these cases were traceable to cattle, either directly or indirectly.

*Trichophyton equinum* was isolated from one horse out of the 36 examined representing 2.78 percent. Such dermatophyte was recovered from diseased human lesions by many workers as MARTON & CHERID, (1972).

*Trichophyton mentagrophytes* was recovered from Pigs (7.02%), buffaloes (5.66%), Cattle (2.90%), horses (2.78%) and dogs (2.08%). This type of fungus was encountered in mycotic affection of man (REFAI, 1967 & SMITH *et al*, 1969) and animals (GEORG *et al*, 1957 & PEPIN *et al*, 1968). Besides, it has the ability to survive in soil in spite of the antagonistic potentialities of the constituents of this medium and the local microbial flora. The role of soil as a vehicle in transmitting this agent to man was explored by many workers as DEMBOVITCH (1963) and EVOLCEANU *et al* (1966) who stated that *Trichophyton mentagrophytes* isolated from infected human beings was of soil origin. However, evidence has been presented that it is abundant in areas frequently inhabited by domestic animals and is found most often on the hair of burrowing rodents which have no lesions attributable to it (HULL, 1963). Moreover infection of human beings with *Trichophyton mentagrophytes* contracted from animals had been recorded by HULL (1963) as a cause of severe suppurative ringworm cases.

*Microsporum gypseum* was recovered from donkeys (4.62%), sheep (4.26%), camels (3.57%), dogs (3.13%) and pigs (1.75%). This organism is quite commonly found as a saprophyte in the soil and occasionally found as a dermatophyte on man and animals. However, it was recovered from human ringworm by many workers as SMITH *et al* (1969). Also it was incriminated in mycotic infections of different animals by KAPLAN *et al*, 1957; REFAI *et al*; 1965 and others.

*Keratinomyces ajello* was recorded from sheep (2.13%) and cattle (1.45%). This dermatophyte is one of the geophilic fungi which is fairly common in the soil of many parts of the world. It occasionally affect animals.

*Trichophyton terrestre* was isolated from cats (9.1%), goats (2.94%), dogs (2.08%) and donkeys (1.54%). This fungus was generally considered to be non-pathogenic (SMITH *et al*, 1969). in spite of its isolation from mycotic infected cases. It was isolated from skin diseases of man (REIRSOL, 1962) and animals (Connale, 1965).

The results achieved, allow to conclude that the clinically healthy animals may harbour certain pathogenic fungi on their skin and hairs. This is partly due to the fact that the dermatophytes may continue to reside on the skin of animals after clinical recovery, thus resulting in the establishment of an asymptomatic carrier state. Besides, the unhygienic housing condition, close contact between animals, high temperature and mal-nutrition especially deficiencies in vitamin A as well as the essential trace elements, all these conditions can play an important role in the establishment of this carrier state. Any how these animals can thus act as carriers of dermatophytes and cross infection may occur between animals and also between animal and man.

## REFERENCES

- Alieva, R.K. and Nechaeva—Pugachera, E.V. (1974). Osobennosti techeniya mikrosporij V Poslednie gody. Vestnik Dermatologii i Venerologii 5, 81-84. Cited by Review of Medical & Veterinary Mycology Vol. 10, No. 1, P. 14.
- Badillet, G. (1973).—Le parasitisme animal/homme. Etude, clinique humaine et epidemiologique. Economie et Medicine Animales 14 6, 353-359. Cited by Review of Medical & Veterinary Mycology Vol. 10, No 2, P. 114.
- Baxter, M. (1973).—Ringworm due to *Microsporum canis* in cats and dogs in New Zealand. New Zealand Veterinary Journal 21, 3, 33-37. Cited by Rev. Med. & Vet. Mycology Vol. 9, No. 1. P. 8-16.
- Blank, F. (1955).—Dermatophytes of animal origin transmissible to man Amer. J. Med. Sci. 229, 302-316.
- Bodin, E. (1816).—Les Teignes Tondantes du Cheral et Leurs Inoculations Humaines. Paris These. Cited From Veterinary Medical Mycology. Edited by Jungerman, P.F. & Schwartzman, R.M. Lea & Febiger. Philadelphia (1972) : 3-28.
- Bohm, K.H. & Loliger, C. (1969).—Die Verbreitung von Dermatophyten bei Pelztieren (Nerz und Chinchilla) Zentbl. Vet. Med. 16 B, 9, 775-783.
- Chemel, L. and Valentova, M. (1966). Epidemiologicka studia zoonoznych dermatomykez dolnych Koncatin. Cslka, Derm. 41, 5, 304-308. Cited by Rev. Med. & Vet. Mycology Vol. 6, No. 4, P. 189.
- Connale, M. (1965).—Keratinophilic fungi on cats and dogs. Sabouraudia 4, 45.
- Dembovitch, A. (1963). Rol Pochry : Poleryth myshei V epidemiologii glubokoi trikhofitii. Vest. Derm. Vener. 37, 19. Cited by Ahmed, M.A. M.D. Vet. thesis (Mycology). Assiut University (1975).
- El-Bahay, G.M. and Refai, M. (1973). Cats and dogs as potential carriers of *Microsporum canis*. Journal of the Egyptian Vet. Med. Ass. 33, 1/2, 63-69.
- Evolesanu, R. and Alteras, I. (1966). The pathogenic properties of some geophilic dermatophytes found in Romanian Soil. Mykosen 2, 133.
- Georg, L.K. (1960). Epidemiology of the dermatophytoses source of infection mode of transmission and epidemicity. Ann. N.Y. Acad. Sc. 89, 69-77.
- Georg, L.K.; Hand, E.A. and Menges, R.A. (1956). Observations on rural and urban ringworm. J. invest. Dermat. 27, 335-353.
- Georg, L.; Roberts, C., Menges, R. and Kaplan, W. (1957). Trichophyton mentagrophytes infection in dogs & cats. J. Amer. Vet. Med. Assoc. 130, 427.
- Gruby (1843). Cited from Veterinary Medical Mycology Edited by Jungerman, P.F. & Schwartzman, R.M., Lea & Febiger. Philadelphia (1972): 3-28.
- Assiut. Vet. Med. J. Vol. 4 No. 7 (1977).

- Hull, T.G.** (1963). Diseases transmitted from animals to man. 4th Edition. Charles C Thomas Publisher, Springfield, Illinois, U.S.A.
- Kaplan, W.; Hopping, G. & Georg, L.K.** (1957). Ringworm in horses caused by dermatophyte *Microsporum gypseum*. *J. Amer. Vet. Med. Assoc.* 131, 329-332.
- Kaplan, W.G.; Georg, L.K. & Ajello, L.** (1958). Recent developments in animal ringworm and their public health implications. *Ann. N.Y. Acad. Sci.* 70 636-649. Cited from *Veterinary Medical Mycology*. Edited by Jungerman, P.F. & Schwartzman, R.M. Lea & Febiger. Philadelphia (1972): 3-28.
- Marton, K. and Cherid, A.** (1972). Le flore dermatophytique du La region algeroise. *International Journal of Dermatology* 11, 3, 173-176.
- Matruchot, L. and Dassonville, C.** (1898). Sur un Nouveau Trichophyton Produisant L'herpes chez Le Cheval. *Comp. Rend. Acad. Sci., Paris*, 127, 279-281. Cited from *Veterinary Medical Mycology*. Edited by Jungerman, P.F. & Schwartzman, R.M. Lea & Febiger. Philadelphia (1972): 3-28.
- Moss, E. and McQuown, A.** (1969).—Atlas of Medical Mycology 3rd. Edition. The Williams & Wilkins Company. Baltimore.
- Pascoe, R.R. & Connole, M.D.** (1974). Dermatormycosis due to *Microsporum gypseum* in horses. *Aust. Vet. Journal* 50, 9, 380-383.
- Pepin, G.A. & Austwick, P.K.C.** (1968). Skin diseases of domestic animals 11. Skin disease of mycological origin. *Vet. Rec.*, 82, 8, 208-214.
- Refai, M.** (1967). Contribution of the dermatophilic flora of N. Egypt. *Mykosen* 10, 61.
- Refai, M. and Reith, H.** (1965). Dermatormycosis in a cow caused by *Microsporum gypseum* *Bull. Pharm. Res. Inst.* 56, 11.
- Reirsol, S.** (1962). Mycological investigation of diseased nails and skin in 131 patients. *Acta Path. Microbid. Scand.* 54, 30.
- Riddell, R.** (1950). Permanent stained mycological preparations obtained by slide culture. *Mycologia* 42, 265.
- Sabouraud, R.** (1894). Les Trichophyties Humaines. Paris, Rueff et Cie. Cited from *Veterinary Medical Mycology* Edited by Jungerman, P.F. & Schwartzman, R.M. Lea & Febiger. Philadelphia (1972) : 3-28.
- Scheklakow, N.D., Stephanowa, J.W. and Leschtschenko, W.M.** (1972). Einige Fragen der Epidemiologie Klimk und Behandlung der durch *Microsporum Lanosum* bedingeten Mikrosporic Mykosen 15, 4, 153-164.
- Smith, J.M.B.; Rush-Munor, F.M. and Mclarthy, M.** (1969). Animals as a reservoir of human ringworm in New-Zea *Aust. J. Derm.* 10, 3, 169-182.
- Stepanova, ZH. V. and Davydov, V.I.** (1970). O nostilstre pushistogo mikrosporum a klinicheski zdorovymi Vest. *Derm. Vener.* 44, 3, 42-46. Cited by *Rev. Med. Vet. Mycology* Vol. 7, No 3, P 113.
- Vanbreuseghem, R.** (1952). Biological technique for the isolation of dermatophytes from soil. *Ann. Soc. Belge. Med. Trop.* 32 173. Cited by Ahmed, M.A. (1975) M.D. Vet. Thesis (Mycology). Assiut University.

1911, p. 100. The same author also published a paper on the same subject in 1912, p. 100.

1912, p. 100. The same author also published a paper on the same subject in 1913, p. 100.

1913, p. 100. The same author also published a paper on the same subject in 1914, p. 100.

1914, p. 100. The same author also published a paper on the same subject in 1915, p. 100.

1915, p. 100. The same author also published a paper on the same subject in 1916, p. 100.

1916, p. 100. The same author also published a paper on the same subject in 1917, p. 100.

1917, p. 100. The same author also published a paper on the same subject in 1918, p. 100.

1918, p. 100. The same author also published a paper on the same subject in 1919, p. 100.

1919, p. 100. The same author also published a paper on the same subject in 1920, p. 100.

1920, p. 100. The same author also published a paper on the same subject in 1921, p. 100.

1921, p. 100. The same author also published a paper on the same subject in 1922, p. 100.

1922, p. 100. The same author also published a paper on the same subject in 1923, p. 100.

1923, p. 100. The same author also published a paper on the same subject in 1924, p. 100.

1924, p. 100. The same author also published a paper on the same subject in 1925, p. 100.

1925, p. 100. The same author also published a paper on the same subject in 1926, p. 100.

1926, p. 100. The same author also published a paper on the same subject in 1927, p. 100.

1927, p. 100. The same author also published a paper on the same subject in 1928, p. 100.

1928, p. 100. The same author also published a paper on the same subject in 1929, p. 100.

1929, p. 100. The same author also published a paper on the same subject in 1930, p. 100.

1930, p. 100. The same author also published a paper on the same subject in 1931, p. 100.