FUNGAL INFECTION OF THE FRUIT WALL OF *ENIGMOCARPON PARIJAI* SAHNI

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ABSTRACT—In the present paper is described a new type of rust-fungus, *Shuklania enigmocarponae*,* infecting the fruit *Enigmocarpon parijai* Sahni collected from Mohgaon-Kalan village, Chhindwara district, Madhya Pradesh. The fungus appears in the form of fungal cups or sori just below the epidermal layer of the fruit. The cups are either open or closed, a fact obviously due to the slightly oblique plane through which the cups have been cut. The cups vary in size and are empty; others show either bicelled teleutospores or septate mycelia, or both spores as well as mycelium. Hyphae are septate, closely compact and profusely branched. In several cups, mycelium is meagre and the bicelled spores are seen in organic union.

The spores occur either in groups or isolated. Where in groups, they appear to have been held together by some gelatinous substance.

The present fossil fungus, *Shuklania enigmocarponae*, seems to be in teliospore stage and not a single uredospore is found inside the sori. Comparisons of this new genus have been made with the living genus *Puccinia* on wheat and *Gymnosporangium*.

The foregoing suggests that this genus belongs to *Basidiomycetes* and was in the last stage of producing the teliospores.

INTRODUCTION

OUR knowledge of fossil rust-fungi from the Intertrappean beds of Madhya Pradesh, which otherwise are exceedingly rich in fossil flora, is quite meagre. Only some types belonging to a few other groups have been recorded of which *Palaeosordaria* and *Perisporiites* (Sahni, 1943) are quite well preserved. (Mrs.) Dr. Chitaley recorded some zygospores which could be traced to Mucorales (Chitaley, 1950). The late Prof. B. Sahni recorded for the first time septate mycelia in the seed coat of the fruit *Enigmocarpon* (Sahni, 1941–43). The material recorded in the present paper is a further contribution in the same direction.

MATERIAL AND METHOD

The present material was discovered by the author while slicing a black chert from the Tertiary beds of Mohgaon-kalan locality (Sahni, 1934). These cherts revealed, besides some new forms which are to be described separately, several fruits of *Enigmocarpon* with their fruit walls beautifully preserved, often in minutest detail. To study the material more clearly, the cut surfaces of a few selected slices were polished with fine carborundum powder and later, with a better evolved technique, several peel sections were taken from these slices. Some of these peels were as large as 6″×4″ and were uniformly thin without hardly any crack, break or rup-

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ture. The advantage of these large peels has been considerable since they could provide enough scope for studying the material in relation to its environmental tissues, some of which were closely related to it.

One of these peel sections contained an excellent transversely cut fruit 19mm.×9mm. with its seven loculi intact. It possibly got flatly pressed before preservation and hence a wide opening is seen on one side. No contents are visible inside the fruit.

It is interesting to note that a few locule walls (Pl. 5, fig. 1 ; text-fig. 1) exhibt some well preserved fungal cups along their rims. The cups are usually single. On one locule wall even three cups have been observed (Pl. 5, fig. 2; text–fig. 3)

The cups may either be open or closed, a fact obviously due to a slightly oblique plane through which the cups have been cut. The number of cups all along the fruit wall in section no. 1 totals upto 18, of which nearly 10 are empty, 2 contain the mycelium and 4 contain fairly well preserved bicelled spores, either scattered or in small groups.

DESCRIPTION

The cuticular layer of each locule is more or less disorganised. The epidermal layer is intact. Below this layer are seated the fungal cups which greatly resemble the sori of Ascomycetes and Basidiomycetes of parasitic fungi.

Cups—The cups occur scattered along the rim of the fruit, all over its outer surface. These are fairly prominent and their number varies in the peel sections taken after grinding every 5mm. thickness of the fruit. The cups are wider than high. The round, domeshaped upper covering of the cups seems to be made either of the epicarp or the thin outer cuticular layer of the fruit (Pl. 5, fig. 2; text-fig. 3).

The cups vary in size. Some are empty while others show either bicelled spores or mycelia or both spores as well as mycelia. The biggest of these cups measure 143μ×240μ, medium ones 157μ×113μ and the smallest 93μ×50μ in slide no. 1.

Mycelium—The mycelium is often abundant inside the cups, infecting the hypodermal tissue of the host (Pl. 5, fig. 4; text–fig. 2). The hyphae are generally 1.1μ broad, septate, closely packed and profusely branched. The remnants of the septa are seen at places. In several cups the mycelium is meagre and bicelled spores are seen lying *in situ*. This, obviously, is a comparatively advanced stage of fungal infection.

Spores—The spores are either in groups (Pl. 5, fig. 5; text-fig. 4) or isolated (Pl. 5, fig. 6;

Sl. No.	Fungal Cups		Cups with spores	Cups with mycelia	Cups with spores and mycelia	Empty cups	Size of the cups			Number of the spores in the cup	Size of spores
	Closed	Open					Biggest	Medium	Smallest		
1.	18	—	4	2	2	10	143μ×240μ	157μ×113μ	93μ×50μ	2-75	10μ×3.3μ
2.	Nil	Nil	Nil	Nil	Nil	Nil	——	——	——	Nil	——
3.	3	—	2	—	—	1	150μ×160μ	125μ×95μ	83μ×55μ	2-63	6.7μ×3.3μ
4.	10	3	4	2	—	7	148μ×175μ	120μ×85μ	90μ×60μ	2-90	10μ×3.3μ
5.	14	6	14	—	—	16	150μ×153μ	100μ×83μ	100μ×73μ	2-105	8.3μ×3.3μ

text-fig. 6). Where in groups, they appear to have been held together by some gelatinous substance.

At a later stage the spores got separated. This feature brings the present fungus very close to the living form *Gymnosporangium* of the family Pucciniaceae. Isolated spores are nearly seen in 50% of the cups or even more.

In some cases the spores are seen lying even outside the epidermal layer of the fruit, mostly isolated and some times in groups (Pl. 5, fig. 3; text–fig. 5). Medium-sized spores are nearly always double walled and measure 6.7×3.3mm. When very young, these are round in shape but gradually become oval-shaped at maturity. Each spore is bicellular. It was, however, not possible to study the contents of the spores.

Affinities of the fungus—The fossil fungus seems to be in teliospore stage and not a single uredospore is found inside the sori. It is probable that these fungal cups might have produced the uredospores prior to the present stage. Septate mycelia are well preserved. The septa, being very thin and few, are, however, partially preserved.

Comparisons of the new genus have been made with the living genus *Puccinia* on wheat and *Gymnosporangium*. With these there is a very close resemblance. The only difference is in the size of the spores and the thickness of the mycelium (Erikson, 1930). The present spores are nearly a quarter in size of the teliospores of *Puccinia* and the mycelia are also thin.

All these facts lead to the evidence that the present fossil fungus belongs to the Basidiomycetes.

The mycelia of the fossil fungus might have infected some other plants growing very close to the plant *Enigmocarpon* or *Sahnianthus parijai* Shukla, at marshy places. The uredospores produced on the unknown host might have infected the fruit *Enigmocarpon* producing teliospores and thus completing its life cycle. These double-walled and bicellular spores were well adapted for unfavourable ecological conditions.

The group Basidiomycetes is divided into the following two orders.

A. Ustilaganales—Members always produce either unicellular spores or more than two spores in a group.

B. Uredinales—Members produce five types of spores (pycnospores, aeciospores, urediniospores, basidiospores and teliospores) the teliospores developing inside the sori or telia.

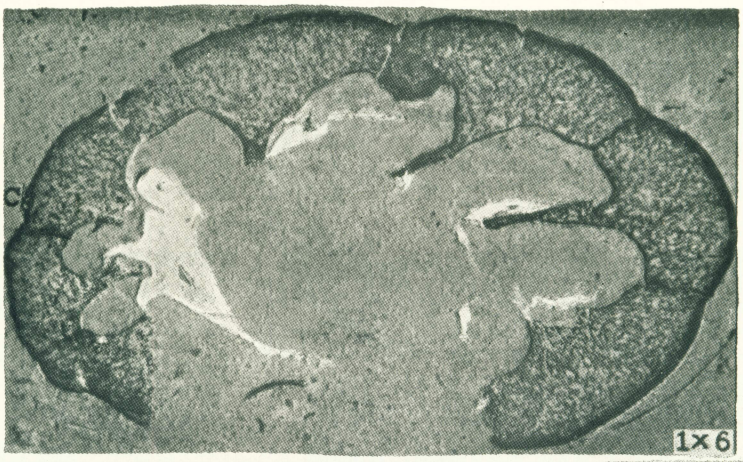
Of the above two classes the present genus may be referred to the order Uredinales which has been further split up into the following families

1. Coleoporiaceae : True teliospores are lacking.
2. Melampsoraceae : True teliospores are present.

Explanation of Plate 5

(The photographs are all from untouched negatives)

1. Sectional view of the fruit *Enigmocarpon* with fungal cups (C) below the epidermis. X6.
2. Sectional view of the fruit wall with three fungal cups (C). X48.
3. A portion of epidermis (E) with teleutospores (S) young and old. X720.
4. A fungal cup filled with branched and septate mycelia (M). X 250.
5. A fungal cup (C) filled with isolated teleutospores and a group of spores (S) outside the epidermis. X 480.
6. Numerous thick-walled teleutospores inside a fungal cup. X 1080.
7. Some teleutospores highly magnified. X2772.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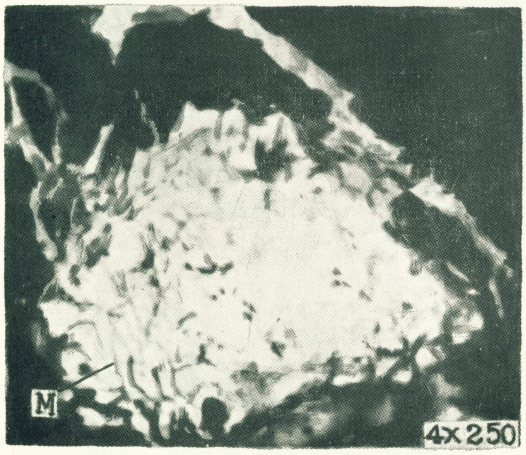
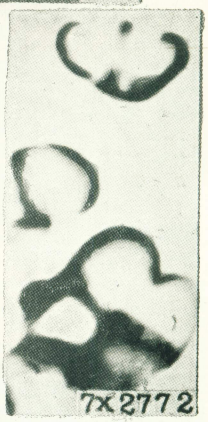

M
4x250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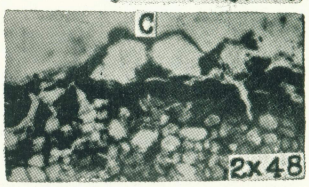
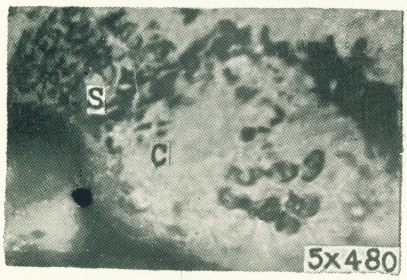
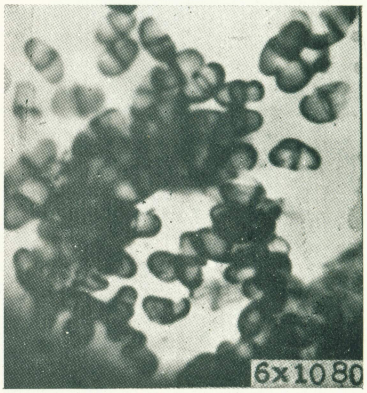

C
2x48


S
C
5x480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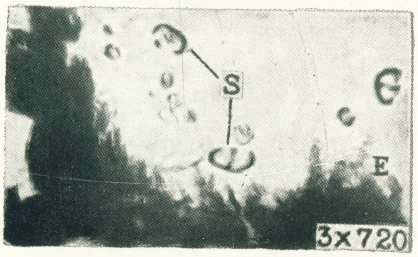
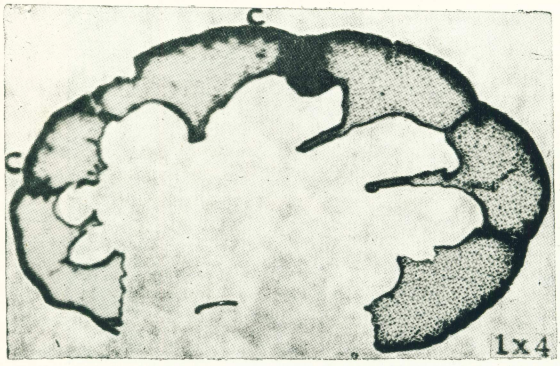
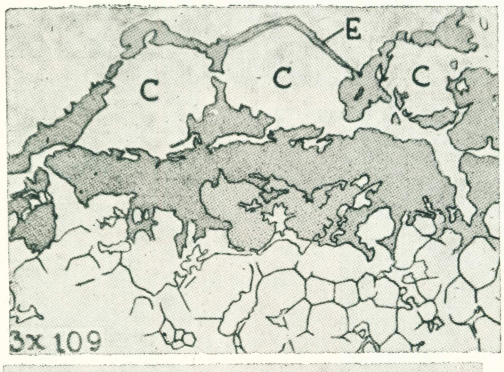
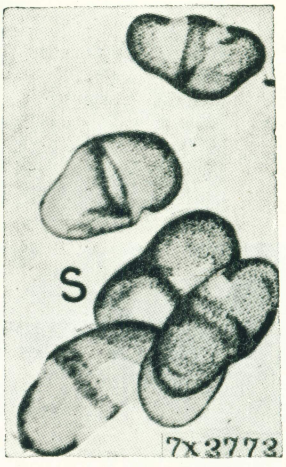
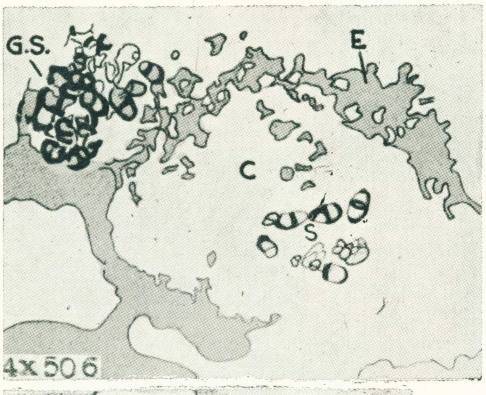
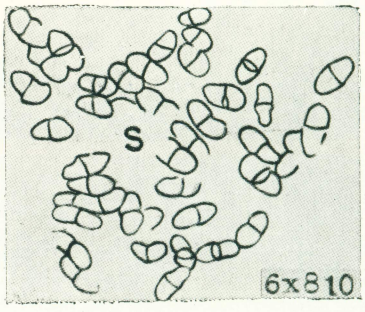

S
E
3x720

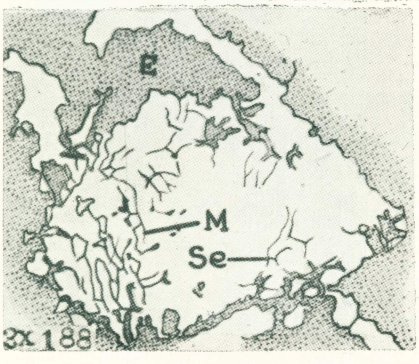

C
C
1x4

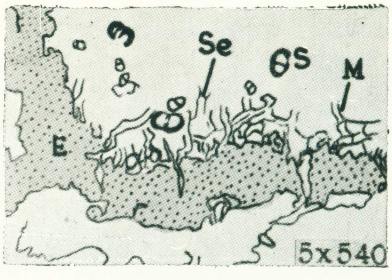

E
C
C
C
3x109


S
7x3772


G.S.
E
C
S
4x506


S
6x810


E
M
Se
3x188


Se
S
M
E
5x540

TEXT-FIGS. 1-7

3. Cronartiaceae : X

4. Pucciniaceae : True teliospores present.

The fossil fungus is thus traceable to the families Melamposoraceae and Pucciniaceae. Of the many genera of these two families *Uredinopsis* of the family Melamposoraceae and *Hemileia* and *Puccinia* of the family Pucciniaceae show close resemblance to the present genus.

The new genus of rust fungi may be considered allied to Basidiomycetes, order Uredinales and the family Pucciniaceae nearer to the genus *Gymnosporangium* and *Puccinia*.

NAME OF THE FUNGUS

The new genus is named *Shuklania,* the name being given after Prof. Shukla who first discovered the petrified flower *Sahnianthus parijai* Shukla of the fruit *Enigmocarpon* from Mohgaon-kalan locality and which has been infected by the fungus described here.

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Name	Mycelium	Teliospore
Uredinopsis	Septate	Arise in scattered groups below epidermis occasionally a few in mesophyll.
Hemileia	Septate	Spore ball is formed (bound together by a gelatinous sheath).
Puccinia	Septate, quite thick.	Double walled bicellular spores of prominent size.
Fossil fungus (*Shuklania*)	Septate, half the thickness of *Puccinia*, remnants of septa visible.	Spores inside sori, like *Puccinia*, thick walled, $\frac{1}{4}$ in size that of *Puccinia*.

EXPLANATION OF TEXT-FIGS. 1-7

1. Sectional view of the fruit *Enigmocarpon* with fungal cups (C) below the epidermis. X4.
2. A fungal cup with mycelia. M, mycelia; Se, Septum; E, epidermis of fruit wall.X 188.
3. A portion of fruit wall with three fungal cups. C, fungal cups; E, epidermis. X109.
4. Sectional view of a fungal cup with spores. C, fungal cup; E, epidermis; G. S., group of spores outside the cup; S, teleutospores in the cup. X 506.
5. A portion of the infected epidermis of the fruit. M, mycelia; S, teleutospores; Se, septum. X540.
6. A group of teleutospores of a fungal cup. S, teleutospores. X810.
7. Some thick-walled bicellular teleutospores very highly magnified. S, spores. X2772.

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