INCIDENCE OF FUNGAL ATTACK ON AIRCRAFT FUSELAGE

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Incidence of fungal attack on the fuselage of a few Vampire aircraft has been observed. The fungus isolated from the infected regions has been tentatively identified as *Torula Sp.* Laboratory experiments have revealed that within four weeks this fungus causes about 44 percent loss in the tensile strength of the birch plywood used in the manufacture of the fuselage of the aircraft.

The wooden parts of aircraft are subject to fungal attack whenever the storage or user conditions favour accumulation of moisture[1]. During servicing/repair of the Vampire aircraft, some cracks on the painted and doped cloth covering of the fuselage and its loosening from the plywood surface were observed. On removal of the painted and doped cloth from the affected regions, blackish patches and cracks were observed on the birch plywood panels used in the fabrication of the main body of the aircraft. In one of the aircraft, the growth was much severe as compared to the others. It was learnt that the particular aircraft had done over 1000 hours of flying and was mostly deployed in the hot and humid regions. On a closer visual examination, it was found that the laminates of the plywood panels had also developed cracks and had become loose (Fig. 1)

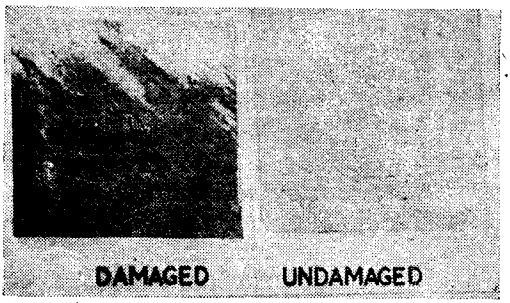

Fig. 1—Condition of an infected plywood panel as compared to an undamaged panel.

This paper describes the results of the studies on the incidence of fungal attack, isolation of the fungus and estimation of the extent of damage caused by the fungus to the plywood panels of the fuselage of the infected aircraft.

EXPERIMENTAL PROCEDURE

Laboratory examination—For detailed examination of the infected regions, small pieces (about $2'' \times 2''$) of the plywood as well as the doped cloth covering were carefully cut from the body of the aircraft. Microscopic examination revealed numerous cracks in the plywood and loosening of the laminates due to mycelial remifications. In pieces showing heavy growth, two of the three plies were found very badly cracked while the third ply

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showed moderate to heavy cracking. As the presence of the fungal growth was confirmed, it was decided to isolate the organisms and study the extent of damage caused to the birch plywood panels under favourable conditions of growth.

Isolation of the fungus—Infected plywood panels, doped cloth covering and the inner filling material (pith-like very light and soft wood) were examined under microscope after cutting thin slices of these materials. Small bits of these materials were then thoroughly washed in sterile water several times to remove the superficial matter and surface impurities. The pieces were then aseptically transferred to Petri dishes containing Potato Dextrose agar (P.D.A.), Nutrient agar (N.A.) and Malt agar (M.A.) media[2]. The Petri dishes with P.D.A. and M.A. media were incubated at 30°±2°C, while those containing nutrient agar medium were incubated at 35°±2°C. There was no bacterial/fungal growth on the N.A. medium but growth of *Torula Sp.* emanating from the pieces of infected plywood panels was observed on P.D.A. and malt agar media. The doped cloth and the inner filling material showed no growth on any media. The isolated fungus was purified and accessioned in our stock collection as "DRL (M) culture No. 963".

Nature and extent of damage to birch plywood by Torula Sp.—In order to determine the actual loss in the tensile strength and shear strength of the birch plywood due to growth of *Torula Sp.*, test pieces conforming to the size and shape as specified in the Indian Standard Specification for plywood for general purposes[3] , were subjected to mycological test using *Torula Sp.* (DRL (M) culture No. 963) as the test organism. Two enamel trays, containing about 3 cm. thick layer of semul saw dust moistened with 1 per cent sucrose solution were prepared. In each tray four test pieces for tensile strength and four test pieces for shear strength test were placed on the saw dust surface and the trays were covered with glass sheets of the size of the trays. The glass sheets were then firmly fixed to the rim of the tray with an adhesive tape so as to completely seal the test samples. The trays were then sterilised in a steam autoclave at 15 lb. pressure for 20 mts. After sterilisaton the samples in one of the trays were inoculated by spraying the spore suspension of *Torula Sp.* while the samples of the other tray were kept uninoculated to serve as control. After inoculation, both the trays (inoculated as well as uninoculated control) were sealed again and put for incubation at 30°±2°C. After 14 days incubation, the test pieces were examined for the degree of fungal growth and the loss in shear and tensile strengths were determined as per I.S. Specification No. IS: 303–1960[3]. As compared to control samples, the inoculated test samples showed a loss of 30% and 24% for shear and tensile strengths respectively. However, it was noticed that the test samples cut parallel to the grain direction of the face veneers of the plywood showed more loss in tensile strength than the samples cut horizontally to the grain direction of the face veneers. Similarly in the case of shear strength, majority of the test replicates broke from the grooves made on them to facilitate the ingress of the inoculum upto the middle core, instead of shearing from the glued surfaces. This was probably due to extra-thinness of the plywood pieces. The test was repeated after increasing the gap in between the two grooves from 1/2″ to 1″ but the results obtained were similar. In view of these observations, it was decided to give up further shear strength tests and prolong the incubation period of the tensile strength tests to 28 days to allow the fungal mycelia to penetrate the surface of the veneers of the test samples and reach the middle core. The number of replicates was increased to ten (i.e. five along the grain direction and five across the grain direction of the face veneers of the plywood). Similar sets of uninoculated control samples were also put along with the inoculated samples by the method described earlier. The results are given in Table 1.

TABLE 1

LOSS IN TENSILE STRENGTH OF THE BIRCH PLYWOOD DUE TO GROWTH OF *Torula Sp.*

Samples	Grain direction	Replicate number	Degree of growth	Tensile strength in Kg.	Average T.S. in Kg.	Per cent loss in T.S.
Inoculated	Across the grain direction of face veneers.	A_1	++	576		
		B_1	++	634		
		C_1	++	691	599	33·5
		D_1	++	576		
		E_1	++	518		
	Along the grain direction of face veneers.	G_1	++	576		
		H_1	++	576		
		I_1	++	576	541	43·6
		J_1	++	518		
		K_1	++	461		
Uninoculated control	Across the grain direction of face veneers.	A_2	—	806		
		B_2	—	998		
		C_2	—	864	902	
		D_2	—	920		
		E_2	—	920		
	Along the grain direction of face veneers.	G_2	—	1152		
		H_2	—	864		
		I_2	—	920	·960	
		J_2	—	864		
		K_2	—	998		

—No growth ++Moderate growth

It will be observed from Table 1 that the test samples along the grain direction of the face veneers show a loss of about 44 per cent while samples across the grain direction show a loss of 34 per cent in the tensile strength of the birch plywood panels. Both these losses are considered significant to render the plywood panels unserviceable.

DISCUSSION

The climatic conditions in the major portion of India are very conducive to microbial growth as a result of which a very wide range of materials are deteriorated by the micro-organisms. The fungal growth on the aircraft fuselage noticed in the present studies is probably the first observation of its kind in India. The aircraft which developed fungal growth have mostly been in operation in hot and humid regions for long durations. The fuselage of the Vampires is made from timber, plywood and light weight closely woven cotton fabric; all these materials are highly susceptible to microbial attack. On the timber airframe, are fixed panels of birch plywood, to give a shape to structure from inside as well as outside. The spaces between the inner and outer panels of birch plywood are filled up with a very soft and light pith-like wood to give added strength to the walls of the plane's body. The exterior of the plywood panels are covered with a very light and closely woven cotton fabric which is firmly glued to the plane's body. A thick coat of aluminium paint (about 1 mm. thick) is provided to give the body of the aircraft a smooth and metal like shining appearance. Due to prolonged use in the rigorous climatic conditions, the painted surface develops minute cracks, through which the moisture penetrates to the plywood panels making it susceptible to the action of the micro-organisms. The growth of *Torula Sp.* is quite significant. If suitable preventive measures are not taken, the incidence of *Torula Sp.* on the aircraft fuselage might render it completely unserviceable.

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