

acids, metaphosphate, insoluble nitrogen and cell division in young biotin-deficient *P. imundatus* cultures.

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¹ Valadon, L. R. G., Manners, J. G., and Myers, A., *Trans. Brit. Mycol. Soc.* (in the press).

² Ahmad, F., Rose, A. H., and Garg, N. K., *J. Gen. Microbiol.*, **24**, 69 (1961).

³ Lilly, V. G., and Barnett, H. L., *Physiology of the Fungi* (McGraw-Hill, 1951).

⁴ Valadon, L. R. G., Myers, A., and Manners, J. G., *J. Exp. Bot.* (in the press).

⁵ Valadon, L. R. G., Manners, J. G., and Myers, A., *Nature*, **190**, 836 (1961).

Nitrogen Source in Fungal Decomposition of Wood

It is a well-known fact that the nitrogen content of the medium is one of the limiting factors in fungal decomposition. Two experiments were carried out in order to determine whether the effective destruction of wood by *Merulius lacrymans* is sustained solely by the amount of nitrogen originally present in the wood, or whether any fixation of nitrogen from the atmosphere might possibly occur. Small cubes of wood were used in Exp. 1 and wood shavings in Exp. 2; the procedure, largely the same in both, was as follows:

A heap of cubes or shavings from pine sapwood, placed on a table and protected from dust, was left in the atmosphere of an ordinary room until, after about a week, constant weight was reached. Samples of 5 or 10 g air-dry cubes or shavings were transferred to Kjeldahl flasks and sterilized. After inoculating every second flask with *Merulius*, all flasks were stored, necks horizontal, at 24° in a constant-temperature room. During storage both test and control flasks received at intervals the same amounts of sterile water to keep them moist. At the conclusion of the experiments all the control flasks were still quite free from fungal growth and the cubes or shavings seemed quite fresh. The inoculated wood was fully decomposed leaving only some brown powder in the mycelium.

After 2 (in Exp. 1 only), 4, 6 and 8 months of storage the contents of three control flasks and three inoculated flasks were subjected to the Kjeldahl procedure. As no clear influence of storage time could be detected in the nitrogen figures, the mean values are given in Table 1.

Table 1
No. of flasks (excluding failed analyses) Average N-content mg/air-dry wood Deviation $\pm \sqrt{\frac{\sum d^2}{n}}$

Exp. 1, wooden cubes:			
Inoculated	14	0.71	0.13
Controls	13	0.57	0.07
Exp. 2, wood shavings:			
Inoculated	8	0.48	0.05
Controls	8	0.445	0.05

The difference in the final nitrogen content in Exp. 2 is not significant, and in Exp. 1 only barely so; thus scarcely lending much support to any theory of nitrogen fixation. The weak point of the method, however, is obviously the heterogeneity of the wood samples.

Before proceeding further with these long-term experiments we would like to invite criticisms of the method. Apart from greatly increasing the number of trials, there are perhaps alternative procedures which might be adopted. The possibility of using sawdust, which might be more homogeneous, has been considered but we have noticed that the growth of *Merulius* was better on the cubes than on the shavings but worse in sawdust. A method of promoting faster growth on woody materials is desirable, thereby decreasing the experimental time.

(Drying the material at higher temperatures was avoided, owing to irreversible drying-swelling hysteresis which was apparent in some preliminary experiments.)

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ENTOMOLOGY

Origin of Wings in Insects

THE wings of insects are outgrowths of the thorax, quite independent of the limbs. The difficulty of picturing their origin in evolution is that of imagining what selective value they could have had during the primitive stages of their development.

The view that flight started from the surface of the sea by the use of fin-like appendages adapted for swimming¹ has found little support. By analogy with the evolution of wings from the fore-limbs of vertebrates, the wings of insects are commonly supposed to have arisen as fixed paranotal lobes used for gliding^{2,3}. The occurrence of fixed paranotal lobes in fossil Palæodictyoptera is often held to support this speculation.

Walton⁴ claimed that the wings of insects originated from basal parapodial appendages of Polychaetes; and Raw⁵, in proposing likewise their evolution from the dorsal swimming lobes of the parapodia, pointed out that if that were so they would be already furnished with the muscles used for swimming. Pringle⁶, on the other hand, suggests that flight was first evolved in an insect of large size, perhaps a leaping insect, which developed muscles that could control the inclination of the paranotal planes used for gliding; only at a later stage were muscles developed which could move the wings up and down and thus lead to the evolution of slow flapping flight.

The purpose of this communication is to put forward a third suggestion—that the wings may have been evolved neither in aquatic ancestors, nor in large earth-bound insects, but in small aerial species.

As is well known, there is a large aerial fauna of insects and other arthropods extending up into the sky for some thousands of feet⁷. Tetranychid mites make regular migrations into the orchards during the summer months, on days when there is a gentle breeze, by means of silken threads; spiders are carried great distances in the same way. Among the insects it is mainly winged forms which make these aerial migrations; but small hairy caterpillars, such as those of the gypsy moth, can be carried many miles by the wind^{8,9}; one human flea, *Pulex irritans*, was taken at a height of 200 ft.; and wingless Thysanura, Collembola, young stages of Hemiptera and Orthoptera, larvæ of Coleoptera, Lepidoptera and Diptera, and great numbers of wingless ants have been captured at heights up to 5,000 ft.⁷. Such flights must have been common among the earliest terrestrial arthropods.

Although many arthropods possess notal extensions, it is only in the wings of insects and the 'pteromorphs' of certain Oribatid mites that these extensions are hinged¹⁰. Oribatid mites figured among the arthropods collected in the sky by Glick⁷, but they were not abundant.

These aerial migrations are of undoubted selective value in securing the dispersal of many of the species concerned. It is not difficult to imagine conditions under which the provision of light cuticular expansions from the thorax would facilitate 'take-off'. The existence or appearance of muscles which could twist these light planes, as suggested by Pringle⁶, would increase their efficiency in take-off and might even afford some control during landing. Flapping muscles, even of the most primitive type, would increase the efficiency of both take-off and landing still further—although, of course, the greater part of the flight would be wholly passive. In short, very small steps towards the evolution of completely functional wings could at once have selective value.

It is worth pointing out that among the Aphids, which are highly efficient fliers and which migrate in vast numbers, often for hundreds of miles¹¹, it is only at the point of departure and at the point of landing that their movements are under their own control. Once they become well and truly air-borne the Aphids, and even