CONTROL OF BIRDLIFE AT AUSTRALIAN AIRFIELDS

The presence of birdlife at airports has been a constant source of danger—particularly since the introduction of jet aircraft.

A series of papers on gulls and other birds inhabiting airfields was prepared by CSIRO wildlife Research Officers and appeared in the "CSIRO Wildlife Research", Vol. 14, No. 2, in December, 1969.

Two of these papers were reprinted in *S.W.A.N.S.*, Vol 1, No. 1. The third paper is published below.

PAPER 3—ORANGE RUNWAY LIGHTS REDUCE BIRD-STRIKE DAMAGE

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SUMMARY

Insects and spiders which congregate at night around runway lights on airfields form an attractive food source, and thus draw a wide variety of birds and bats into the flight paths of aircraft. Aircraft can be severely damaged when they strike birds or bats. If the number of insects and spiders which are concentrated by runway lighting could be substantially reduced, presumably the frequency of this type of damage to aircraft would also be reduced.

It was found that orange light which excluded wavelengths shorter that 530 mμ attracted fewer insects and spiders by weight than white light of equal visibility to humans with normal vision. A reduction of 92 per cent. was achieved with a Pyrex orange runway light lens, formerly in general use in Australia but now replaced by a variety of white lenses to conform to specifications of the International Civil Aviation Organization.

There are strong indications that these specifications should be amended in the interest of aviation safety to ensure that as many of the short wavelengths as possible are excluded from signal lights, and that orange should be the colour for the main runway lights.

I. INTRODUCTION

From time to time aircraft are severely damaged when they strike birds and bats at high speeds. Birds and bats picked up from the runways of airfields throughout Australia, after they were either struck by an aircraft or shot when attempts were made to disperse flocks, were forwarded to the CSIRO Division of Wildlife Research for examination. Two-thirds of over 200 full stomachs were found to contain mainly insects and spiders.

There are two methods in general use commercially to overcome problems caused by concentrations of insects around lights. One is to attract insects to an ultraviolet light near an electric grid which destroys them by burning. Another method is to use orange instead of white lights and thus concentrate fewer insects.

During November and December 1967, at Tindal R.A.A.F. Base near Katherine, N.T., amounts of insects and spiders concentrated by white and by orange runway lights were compared. During March and April 1968, amounts of insects and spiders concentrated by light screened by three different orange filters and by white and by ultraviolet lights were compared at the Gungahlin Research Station of the CSIRO Division of Wildlife Research, Canberra. The results and their practical implications for aviation safety are presented below.

II. METHODS

(a) *Experiment at Tindal*

The airfield at Tindal had a single sealed runway with 79 white runway lights 200 feet apart down both sides and 4 green lights at each end. The edges of aircraft parking areas were indicated by orange lights. Blue taxi-way lights were not present at the time of the experiment. A wind-sock was illuminated by four white lights above it. The white runway lights and the green end-of-runway lights were connected to the same circuit. The wind-sock lights and the orange parking lights were on other circuits. The airfield area around the runway and taxi-ways consisted of red and black soils with a limestone substrate. The surface had been graded bare. Around the airfield was flat wooded country with some irregular clearings to accommodate airfield buildings and installations.

The experiment started at dusk on November 30 and ended during the morning of December 20, 1967. The 20 nights involved are referred to as nights 1-20. On the uneven-numbered nights the runway lights were all white and on the even-numbered nights they were all orange.

The orange colour was achieved by inserting an orange filter, Strand Electric Cinemoid No. 5, between a white airfield-type light bulb (12V, 48W) and the outer glass cover of each runway light. The current of the runway light circuit was adjusted to 5.8 A for white and 6.6 A for orange light so they would be equally visible to humans with normal vision.

The green end-of-runway lights, being on the same circuit as the runway lights, were brighter and bluer on orange nights than on white nights. The two conditions of the green lights are referred to as high and low green. The orange parking lights and the wind-sock lights were at the same intensity on all 20 nights. The lights were kept burning continuously from before dusk to after dawn. The orange parking lights failed and were off on the seventh night.

Around four runway lights (a-d) (nights 1-20) and two end-of-runway lights (e, f) (nights 7-20) insects and spiders were trapped in white Ilford developing trays (11 x 9 x 1½ in.) filled with a weak Shell Teepol 630 detergent solution. Four trays were placed in a square around the light. The insect catch of a light was filtered out of the solution with cheesecloth which was wrapped into a bag, closed with a piece of string, and stored in alcohol. The catches were removed from the trays between 11 p.m. and midnight, and again shortly after sunrise.

A sample of insects and spiders was also obtained each night with a white light trap placed on the ground under the trees beyond the airfield boundary. The trap consisted of a 150-W white light bulb above a funnel that led into a container filled with tetrachloro-ethane gas. This light burnt at the same intensity on all 20 nights.

The catches were shipped by air in alcohol to Canberra, where they were dried, weighed, and sorted into recognizable taxa.

Around each of eight runway lights, two green end-of-runway lights, and two orange parking lights, a 4½-ft. square of white cheese-cloth was pegged down with roofing nails. Each night between 11 p.m. and midnight, the taxa of insects and spiders visible on the cheese-cloth square and the light were recorded in a notebook. The taxa of insects and spiders present on and around the wind-sock were recorded each night between 7.30 and 8.30 p.m.

With the aid of binoculars and a telescope, observations were made from a temporary control tower of the numbers and kinds of birds visible on the airfield. These observations were made from about 8 to 11 a.m. During the collection of insects and spiders from the trays and the changing of the orange runway light filters at about 7 a.m., notes were also kept of birds seen on the runway. In order to examine what they were eating, several birds were collected with mist nets and by shooting.

(b) *Experiment at Gungahlin*

The research station at Gungahlin consists of a central group of buildings surrounded by animal enclosures and open paddocks which are separated by substantial wind-breaks of many native and introduced species of evergreen and deciduous trees. Near the buildings are two duck ponds, and on a slight slope overlooking these ponds four lights were placed 60 feet apart and in line. The lights consisted of light bulbs inside biscuit tins placed on the ground. On the side facing the ponds light was let out through the following four combinations of filters, each 4 in. square:

(1) White light from a 60-W bulb through one 1.5-mm sheet of frosted perspex.

(2) Orange light from a 100-W bulb through Cinemoid No. 5, and two 1.5-mm sheets of clear perspex.

(3) Orange light from a 100-W bulb through Kodak No. 22 and four 1.5-mm sheets of clear perspex.

(4) Orange light from a 150-W bulb through a Pyrex runway light lens and three 1.5-mm sheets of frosted perspex.

With the aid of transformers and different thicknesses of perspex and frosting the combinations were matched to be equally visible to humans with normal vision. Frosting helped to disperse the light from the Pyrex lens and make it mcre comparable with the other lights.

The lights were kept burning from before dusk to after dawn: March 25-29 and April 1-5, 8-12, 16-20, 1968. The 16 nights involved are referred to as nights 1-16. During the first eight nights the lights were one white, two Cinemoid No. 5, and one Kodak No. 22. During the last eight nights they were one white, one Cinemoid No. 5, one Kodak No. 22, and one Pyrex. The lights were moved daily in rotation around the four positions to eliminate position effects.

Insects and spiders were trapped in white Kodak developing trays (13 x 11 x 2 in.) filled with a weak Shell Teepol 630 detergent solution and placed one in front of each light. Triangular roofs 1½ ft. above the ground shielded the trays and lights from rain and dew. During the same 16 nights, insects and spiders were also trapped by an Oliphant Germicidal ultraviolet lamp (1000 V. 0.040 A) placed in a laboratory window 5 ft. above the ground. The spiders and insects attracted to the ultraviolet lamp were funnelled into two glass containers and killed by tetrachloro-ethane gas. The catches were collected about 9 a.m. and were weighed and sorted into taxa.

(c) *Special Characteristics of Runway Light Filters*

The visual appearance of the colour of the light transmitted through various regular and experimental runway light colour filters is not a criterion on which to base experiments like those cited above. Hence all the filters used during the course of this study were examined with a Zeiss hand spectroscope and checked for any ultraviolet transmission with a fluorescent powder, after excluding all visible light with a Kodak Wratten 18a filter. In this way, filters with known absorption characteristics could be chosen for the experiments.

III. RESULTS

(a) *Quantities of Insects and Spiders Attracted to Lights*

Insects and spiders tended to be more abundant around white and green lights than around orange lights. The weights of the catches around lights of constant colour intensity and location, however, varied greatly, presumably due to humidity, temperature, wind, and other climatic factors. To compare the data for the catches of the various lights they were grouped for each night as follows:

(1) four runway lights (a-d) and the light trap at Tindal;

(2) two end-of-runway lights (e, f) and the light trap at Tindal;

(3) one white and three orange lights at Gungahlin; and

(4) one white and one ultraviolet light at Gungahlin.

Within each group the weights of the catches were converted by angular transformation to arcsin $\sqrt{}$ percentage of the total catch for the group. Comparisons of these conversions and conversion of the means back to percentages gave the following information:—

(1) Orange (Cinemoid No. 5) runway lights attracted 27-43 per cent. less insects and spiders than white runway lights at Tindal. This difference is significant at the 99 per cent. level according to Student's t-test.

(2) The catches of the light trap, the white runway lights, and the high- and low-intensity green end-of-runway lights at Tindal were not significantly different, although high green did catch more than low green.

(3) Orange (Cinemoid No. 5 and Kodak No. 22) lights attracted 48-81 per cent. less insects and spiders than white light at Gungahlin. These differences are significant at the 99 per cent. level. There were no significant differences in the attractiveness to insects and spiders of light filtered by Cinemoid No. 5 and Kodak No. 22.

(4) Orange (Pyrex) light attracted 92 per cent. less insects and spiders than white light, 60 per cent. fewer than orange (Kodak No. 22), and 61 per cent. less than orange (Cinemoid No. 5). These differences are significant at the 99 per cent. level and may be due to the relatively high intensity of the yellow band at about 590 m_μ in the emission spectrum of Pyrex orange.

(5) Ultraviolet light attracted 38 per cent. more insects and spiders than white light but this difference is only significant at the 90 per cent. level.

(b) *Kinds of Spiders and Insects Concentrated by Lights at Night*

There were no major qualitative differences in the occurrence of spiders and insects attracted by lights of different colour and green lights of different intensity.

(c) *Kinds of Insectivorous Birds and Bats that Frequent Australian Airfields*

Seed-eating birds, pigeons, parrots, and finches were present in large numbers around the airfield at Tindal, but spent little time on it because of the scarcity of vegetation and, consequently, of food for them. Nevertheless, it was visited at times by a wide variety and large numbers of insect-eating birds. Sometimes these birds came to feed on back-swimmers, Notonectidae, which landed at night on wet pavements including those of the runway, taxi-ways, and parking areas. Occasionally the birds came onto the airfield to feed on insects knocked out of the sky by a sudden tropical downpour. Usually they appeared to be feeding on insects and spiders concentrated by the airfield lighting at night and still present in the morning. Oriental dotterels and Australian pratincoles were seen feeding around the runway lighting at night. In the morning when the orange runway light filters were being changed and the insect and spider catches were being collected, these bird species were seen feeding on the runway; black kite, whistling kite, brown falcon, Oriental dotterel, Mongolian dotterel, greenshank, Australian pratincole, and black-faced woodswallow.

The average total daily weight (6 lb.) of all birds seen feeding on the runway at that time of day is of the same order of magnitude as the estimated weight (4 lb.) of the nightly average of insects and spiders concentrated around the runway and end-of-runway lights. This is more than ample food for these birds provided it is still accessible to them at that time. Not included in the weight of birds were the thousands of Oriental pratincoles which roosted at night on the airfield. These short-legged birds normally feed like swifts on the wing on flying insects at the edges of tropical cyclones. At night they roosted on areas devoid of vegetation, e.g., large clay pans and airfields. A few, not more than 20 Oriental pratincoles were seen during the morning feeding on the runway together with Australian pratincoles and Oriental dotterels. They appeared clumsy at foraging on the ground in comparison with the other two species which have much longer legs. The other insectivorous birds seen during the morning on the airfield probably also obtained most of their food elsewhere, but they were present in the area and could take advantage of any temporary source available to them on the airfield.

At Darwin, Townsville, Cairns, and Mackay aircraft have struck southern stone-curlews (av. wt. 1½ lb.) at night. The presence of these nocturnal and mainly insectivorous birds among those struck by aircraft and sent to Canberra for identification and autopsy provided the first clue that the airfield lighting might be providing food for at least some of the birds that are damaging aircraft.

It should be realized that some of the larger birds, besides feeding directly on spiders and insects around the lights, may also feed on some of the smaller insectivorous animals including frogs, lizards, snakes, and small birds which forage around the lights. For example, at Cairns, Townsville, and Mackay the introduced cane toad, *Bufo marinus*, is a major link in this food chain. Even large birds which are struck by aircraft can provide food for other birds. While the mantids and ants feed on other insects around the lights, they also provide, directly and indirectly, food for birds.

At night hundreds of little red flying foxes, *Pteropus scapulatus*, fly in long columns over the airfield at Tindal, but they do not stop because of the lack of fruit trees and flowering trees to feed in. Similar numbers of bats were heard hawking after insects over the runway lighting. Gould's wattled bat, *Chalinolobus gouldii*, has been struck by aircraft at Perth and at Alice Springs. It is also known to feed on flying insects around street lights at Canberra and elsewhere. At Tindal, the unpouched sheath-tailed bat, *Taphozous georgianus*, was found breeding in a cave on the airfield perimeter. This species also feeds on flying insects at night.

A wide variety of insectivorous birds is known to have been struck by aircraft in Australia. Each species eats only a selection of the varieties of insects and spiders that are attracted by airfield lighting. Collectively, however, they eat at least two-thirds of all these insects and spiders. There is a slight positive correlation between the occurrence of spiders and various taxa of insects found in airfield birds and bats and their occurrence in the catches around the airfield lights at Tindal.

IV. DISCUSSION

The experiments at Tindal were to explore on an airfield scale whether runway lights concentrate significant amounts of insects and spiders to be a major food source for birds and bats, and whether orange instead of white runway lights would be a practical means of reducing this food source. Birds and bats did seek to find food around the runway lights at Tindal, and presumably they also do so at other airfields when the weather is suitable.

Because Tindal airfield was still under construction it was the only airfield in Australia for the experiments and was available for only 20 days. Ideally there should have been white and orange lights only on the alternate nights; however, this could be done only with runway lights because the other airfield lights had to remain white, orange, or green as signal lights to permit aircraft to use the airfield in an emergency. There were also building lights near the airfield. In addition, on a completed airfield there would have been blue taxi-way lights and red warning lights. It was assumed that owing to the distances of these other lights from the runway lights, their effect on the amounts of insects and spiders concentrated around the runway lights was slight to negligible.

The siting of the white light trap at Tindal was not ideal, but it was the only location available with electricity as far away as possible from other lights. It was assumed that although it was in a different microclimate its catches were mainly affected by the same macroclimate as the airfield. Although the white light trap differed in design and location from the white runway lights its catches did not differ significantly in kind and quantity from those at the white runway lights. It thus provided a reference for comparing the catches of the airfield lights.

The experiments at Gungahlin were to select an orange filter which would concentrate the smallest number of spiders and insects. Ironically it was found to be the Pyrex orange runway light lens, which was in general use in Australia until about a decade ago when it was gradually replaced by a variety of white lenses in order to conform with recommendations of the International Civil Aviation Organization, which require that runway lighting must be white (I.C.A.O. 1964).

V. CONCLUSIONS

The insects and spiders which concentrate at night around white runway lights attract birds and bats into the flight path of aircraft and thus increase the risk of aircraft being damaged through striking these animals.

Orange lights concentrate fewer insects and spiders by weight than white lights of equal visibility to man. Therefore there are strong indications that, in the interest of aviation safety, the rationale behind the requirements for white runway lights should be re-examined and that there should be a further examination of the possibility of using orange runway lights which exclude wavelengths shorter than 530 $m\mu$.

Ultra violet and as much as possible of the short wavelength emissions of the spectrum should be excluded from white and coloured airfield lights.

DO PEOPLE CARE ABOUT CONSERVATION ?

A recent Gallup survey conducted for the National Wildlife Federation in the U.S. showed that most Americans *do care* about conservation.

The survey revealed that:

- **51 Per Cent** of Americans are deeply concerned about deterioration of environment, 35 per cent somewhat concerned and 12 per cent not very concerned.
- **73 Per Cent** are willing to pay additional taxes to improve natural surroundings, 51 per cent would pay $10 or more, 18 per cent around $50 and 4 per cent $100 or more.
- **75 Per Cent** are in favour of setting aside more public land for conservation purposes; 19 per cent not in favour.

The survey also revealed that rural areas and small cities are considered the most pleasant places in which to live; air and water pollution were cited as the most pressing of conservation problems, and opinion seemed evenly divided on the possible necessity of limiting human population.

It would be most interesting to see a similar study conducted in Australia—perhaps sponsored by a National Conservation Body.