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RADAR ENTOMOLOGY – NEW HORIZON IN ENTOMOLOGY

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Introduction

Radar is a system for detecting the presence, direction, and speed of any object (Eg. aircrafts, ships, etc.) by sending out pulses of radio waves which are reflected back off the object. Radar has a more obvious connection with entomology than any of the remote sensing methods because it has been used effectively in direct observations of insects. The pioneering work in radar entomology that radar could be successfully used as a powerful entomological tool was initiated and performed by Schaefer in 1969. Following this pioneering demonstration, application of this technique has led to spectacular advances in the study of long-distance migration and other aspects of flight behavior in the field. Insects cannot perceive radar waves, at least at the power levels used in normal entomological studies, so the technique allows observations of undisturbed, natural behavior. Radar has also been used to investigate windfields affecting airborne insects.

Common Entomological Radars

Most of the radars used to date in entomological studies have been small, mobile, incoherent pulse systems using a wavelength of 3.2 cm and based on commercially available marine systems. These radars transmit from their antennae a narrow, conical beam of short pulses of electromagnetic waves. Any object illuminated by a pulse reflects or scatters some of the pulse energy, and a part of this scattered energy (the "echo") is returned in the direction of the radar. If the echo is strong enough, it is detected and amplified when it reaches the radar receiver, and the presence of a target is registered on a display device. Target direction can be deduced from the orientation and directive properties of the radar antenna, and target range from the time elapsing between transmission of the illuminating pulse and reception of the echo. Typical maximum detection of the received echo ranges between 1.5 - 2.5 km for individual medium-sized (100 mg) insects and up to several tens of kilometers for dense concentrations.

Stages of Operation in Radar Entomology

Two stages of target recognition are required in radar entomology.

1. First, it is vital to discriminate the echoes returned by insects from those of birds, bats, and precipitation;
2. Secondly, it is often necessary to identify the species of insect detected.

The first stage is usually accomplished easily, at least at close range, because the diffuse echo returns from precipitation are very different from discrete insect echoes and because the flying speeds and radar-derived wing beat frequencies of insects usually differ clearly from those of other animals. On the other hand, recognition of individual insect species from their radar returns is made difficult by intraspecies (within a species) spread and interspecies (between species) overlap of wing beat frequency. In most successful radar studies, identification has relied heavily on supplementary evidence of species composition acquired, for example, by aerial trapping or ground sampling in the takeoff area.

Other types of radar

In addition to the "**3.2-cm pulse radars**" that have been widely used for insect flight studies, a number of other types of radar have provided useful entomological observations from time to time:

1. Bistatic and Doppler radars for low-altitude studies
2. Millimetric-wavelength radars
3. Frequency-modulated continuous-wave (FMCW) radars
4. Tracking radars
5. Harmonic radars

Large radar installations : One of the first demonstrations that insects can be followed by radar was made with large, powerful tracking systems. Although large radars offer a substantial range advantage, in practice this tends to be offset by their lack of mobility, by the uncertainty about the degree to which the sensing beam is occupied by insect targets.

Conclusion

Entomological remote sensing using radar and specialized optical techniques is a very active field and has already made major contributions to the study of insect flight. There is considerable promise that techniques currently under development will greatly improve the identification capabilities of entomological radars, and this will facilitate the study of more species.

References

Riley, J. R (1989). Remote Sensing in Entomology Annu. Rev. Entomol 34: 247-271.