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## Discussion on Radar Entomology

W. A. Muller, G. W. Schaefer, J. R. Riley, R. C. Rainey, R. Le Berre, J. W. S. Pringle, D. J. W. Rose, D. E. Pedgley and B. Adefris

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## Discussion on radar entomology

W. A. MÜLLER (*Universität Hohenheim, Stuttgart*)

I would like to ask two questions concerning the accuracy of these radar observations. The first concerns identification; with some species, are there not problems of overlapping distributions of wing-beat frequencies? The second question is how is the accuracy of estimation of density influenced by distance?

G. W. SCHAEFER

On the distance question there is no problem; the equations are well known, and appropriate corrections have been incorporated, either electronically or by computer, in all the estimates presented. If you can estimate absolute density at one distance, you can do it at any distance. But establishing absolute density means knowing a reasonable amount about the species concerned, which comes back to the problem of identification; you need to have a fair idea of the species to know the radar cross section from which you get absolute densities. When our conclusions have been checked, by aircraft netting or against ground-based radar, they have always proved right, both in terms of species and in terms of density. But this has meant, in any one project, getting to know the ecology, the aerial ecology of that area; and it can't be done in a few moments. You need every aid you can get – light traps, suction traps, aerial netting, ground surveying, watching insects take off, catching them during take off, measuring their weight and their water content – these are all things I get the biologists in on immediately we start a project, to pin down the various species around. On top of that, we have the very strong diagnostic tool of wing-beat frequency, related to the range of species we know are possible in the air space over that area, in terms of their biology, ground sampling and so on. You can make predictions, from wing measurements, wind tunnel and field studies, high-speed photography, etc. about what the wing-beat frequencies will be, and their range. While you can't distinguish *Oedaleus senegalensis* for example from *Oedaleus nigeriensis*, there is no problem in separating *Oedaleus* from *Aiolopus*, with a certainty of something like 90%, or from *Locusta*, again with almost no overlap.

J. R. RILEY

We have been very concerned about the problem of identification, and particularly this problem of overlap. What Dr Schaefer has said is true; one always needs as much ancillary information as possible. There have been many occasions when we have been overflowed by insects whose origin might well have been 350 to 400 kilometres away, and about which we had no entomological information at all. Basing interpretation solely on the wing-beat frequency can, in such circumstances, lead to a substantial measure of ambiguity. Thus the answer to the identification problem is not very satisfactory except in exceptional circumstances where one is near a take-off area and can do the sort of intensive ground studies that Dr Schaefer was mentioning, or where aerial densities are high enough to permit aerial netting.

R. C. RAINEY, F.R.S.

On identification, it is good to see how the relation Weis-Fogh (1956) found between Desert Locust wing length and wing-beat frequency in his wind-tunnel studies, as subsequently

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extended by Dr Schaefer (1976) to his own field studies on Sudan grasshoppers, has now been used by Dr Riley to help to confirm his own recognition of radar echoes from *Oedaleus senegalensis* in Mali. What needs emphasis is the case for radar studies in situations where problems of identification are likely to be minimal, for example during the mass take-off of newly emerged African armyworm moths (Brown & Swaine 1966), when even the simplest of radar observations could be expected to provide new and urgently needed knowledge on heights, densities, directions and speeds of flight.

W. A. MÜLLER

Did you observe whether the insects could cross the level of a temperature inversion?

J. R. RILEY

Yes; in the example I showed there was a substantial concentration above the inversion.

R. LE BERRE (*Onchocerciasis Control Programme, Ouagadougou, Upper Volta*)

Maybe Dr Riley or Dr Schaefer could do something with blackfly (*Simulium*)? These methods and techniques are interesting to us.

G. W. SCHAEFER

I expect to start very shortly on long-range detection of individuals and concentrations of blackfly on the Athabaska river, by a different kind of radar, about which we know sufficient to know that it is technically feasible and financially practicable: as well as highly portable.

R. LE BERRE

Could something perhaps be done in the Sudan, where there is *Simulium griseicolle* between the two Niles, or *Simulium damnosum* itself to the north of Khartoum?

G. W. SCHAEFER

We would prefer to work close to some project that is vitally concerned with blackfly: such as your own.

J. W. S. PRINGLE, F.R.S. (*Department of Zoology, University of Oxford*)

Is this equipment the same as you had in the Sudan, or technically different?

G. W. SCHAEFER

Completely different.

D. J. W. ROSE (*C.O.P.R., London*)

May I ask Dr Schaefer or Dr Riley whether they saw a recent *Times* report of a new radar technique for eliminating 'ground clutter', for looking at shipping, and whether this technique might help to make it possible to use a ground radar for looking at insects flying in the immediate vicinity of a light trap?

G. W. SCHAEFER

I think the price of that particular equipment would rule it out; but we have already been able to make some instructive radar observations on the density of insects above an appropriately-sited light trap (Schaefer 1976).

D. E. PEDGLEY (*C.O.P.R., London*)

The vertical cross sections of insect density shown by Dr Schaefer are extremely interesting to a meteorologist, and perhaps begin to give us some idea of the mechanism whereby clouds of insects can become more dense at wind-shift lines. It seems that there is a dense cloud at low levels, probably coming in on the winds which are likely to be strongest at heights of 100–200 m in sea breezes, together with overturning at the front. The concentration is perhaps more an effect of the behaviour of the moths than of the structure of the wind field, though the two of course go hand in hand.

G. W. SCHAEFER

Yes, one has to be very careful about moth behaviour versus meteorological features of wind fields. We were extremely fortunate in crossing that sea-breeze front many times. In the first traverse I showed the insects had only been in the air about ten minutes, and had not changed their orientation since entering the front; they were still following their local wind fields. Half an hour later the orientation was almost completely mixed up inside the whole thing. But one has to be very careful about monitoring both the atmosphere, very precisely, and the insects, also precisely, by radar, and then putting the two together. I think insect behaviour is more important than meteorology in many cases. I am more and more convinced that the insects only let themselves first of all get into the winds they really want to get into, and that they choose their height in relation to where they are going; but when they get into a strong vortex there is only a limited amount of manoeuvring they can make. In that particular sea-breeze convergence was moderate, with up-draughts of perhaps a metre per second, in which they could, if they wanted to, fight their way down to the ground.

B. ADEFERIS (*DLCOEA, Addis Ababa, Ethiopia*)

We are acquiring two aircraft – B.N. Islanders – fitted with radar of some sort for navigational purposes. Could Dr Schaefer tell me whether this insect detection can be done during the day as well as during the night, because most of our surveys have to be done during the day.

G. W. SCHAEFER

The radar will function perfectly well at any time except in the middle of very dense rain.

#### *References*

- Brown, E. S. & Swaine, G. 1966 New evidence on the migration of the African armyworm. *Bull. ent. Res.* **56**, 671–684.
- Schaefer, G. W. 1976 Radar observations of insect flight. *Symp. R. ent. Soc. Lond.* **7**, 157–197.
- Weis-Fogh, T. 1956 Biology and physics of locust flight. II. Flight performance of the Desert Locust. *Phil. trans. R. Soc. Lond. B* **239**, 459–510.