projects were liable to failure, with very grave consequences for both the Colonies and for Britain.

Mr. F. H. C. Butler, director of the Council for the Promotion of Field Studies, explained how this five-year-old body functions, and described how the centres which the Council operates at Flatford Mill, Juniper Hall, Malham Tarn, and Dale Fort might be used to increase the variety of types of field work now possible. These offered to school-children, university students and private individuals alike the opportunity of doing supervised work in the field on biological and related subjects, of observing the interaction of these studies and so counteracting the tendency towards over-specialization. Dr. E. A. Ennion, warden of the Council's centre at Flatford Mill, gave an account of the way in which work there is carried out, stressing in particular the precautions which are taken to ensure that the natural life of the environment is conserved and that rare species are not rendered extinct by over-zealous collecting.

This particular example of a more general danger led the Association to consider the topic of the conservation of the wild life of England and Wales, Capt. C. Diver describing the proposals of the Wild Life Conservation Special Committee. These include the setting aside of certain parts of Britain as Nature reserves and the starting of a State biological advisory service. A specific instance of the way in which properly trained biologists could act to ensure efficient public services and economy of public money was given by Prof. E. A. Spaul, of the University of Leeds, who described some of the work done by zoologists there on the biology of sewage and sewage disposal, much of which has been shown to depend upon the animal population of the filters. Mr. R. S. R. Fitter gave some examples of the type of problem—bird migrations, liberation of populations of known genetic constitution—to which answers might be found by the use of the special category of experimental Nature reserves which are also proposed.

NATURAL SELECTION OF *DROSOPHILA*

RECENT studies on wild populations of *Drosophila* are shedding considerable light on the effects of natural selection. By means of the cytological examination of salivary gland chromosomes, it is possible to analyse the nuclear constitution more precisely than in other living forms. For example, an inversion of part of a chromosome *abcde* to form a different chromosome *adcbe* is not infrequent, and may be quickly detected in the hybrid between two *Drosophila* containing these respective chromosomes. Generally there is no apparent difference in the characters of the individuals carrying normal or inverted chromosome arrangements. Occasionally, however, a large position effect is noted such as in 'roughoid' (Gruneberg, 1939).

Dobzhansky¹ and Dubinin and Tiniakov² have shown that the proportion of individuals carrying an inversion alters with time and place in wild populations of *D. funebris* and in *D. pseudoobscura*. For example, Dubinin and Tiniakov show that the proportions of individuals of *D. funebris* with inversions is lower in urban than in rural districts, and that under the intense natural selection of winter conditions the inversions III, II2 and II4 were greatly reduced in proportion, whereas the inversion IV1

increased slightly. On the other hand, these inversions increased rapidly in proportion during the summer up to a maximum when the population was at its prime.

Similarly, Dobzhansky has shown that cyclic changes with the seasons took place in a wild population of *D. pseudoobscura* at Pinon Flats, California. These changes were on the whole constant during the years 1939–46. There was no trend towards one particular chromosome arrangement, although the proportions in the population were significantly different at different times of each year. This evidence becomes more significant when it is found that the same chromosome arrangements do show a definite trend at Keens Colony, which is 15 miles from Pinon Flats. During the years 1939–46 the standard arrangement increased in the population from 30 to 50 per cent, whereas the 'Arrowhead' arrangement decreased from 30 to 15 per cent. In all these cases no detectable difference in the morphology or physiology of the animals with different chromosomes has been observed.

In *D. pseudoobscura* the inversion heterozygotes are adaptively favoured in comparison with both the homozygotes; but in *D. funebris* there appears to be no difference between the inversion homozygote and the inversion heterozygote in respect of survival value. In each of the above cases either one simple or one compound rearrangement is present on one chromosome; it is expected and found that there is a consequent instability and increased plasticity of the population.

Recently a constant breeding population of *D. funebris* consisting entirely of individuals heterozygous for three inversions on chromosome 5 has been found near Manchester by Berrie and Sansome³. The three inversions are evenly placed on the chromosome, and no homozygotes have as yet been obtained among the forty individuals caught, or in their progeny. A multiple, probably successive, series of chromosome arrangements had occurred and a highly stable heterozygous system was the result. Obviously, the creation of such a system must be fortuitous, at least in respect of the occurrence of the inversions; but natural selection could control the trend of the subsequent evolution.

F. W. SANSOME

¹ Dobzhansky, Th., *Heredity*, 1, 56 (1947).

² Dubinin, N. P., and Tiniakov, G. S., *Amer. Nat.*, 79, 785 (1945).

C.R. Acad. Sci., U.S.S.R., 51, 155 (1946); *J. Gen.*, 48, 11 (1947).

³ Berrie, G. K., and Sansome, F. W. (in the press).

ORIBATID MITES AND THEIR ECONOMIC IMPORTANCE

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REVIEWING some of the literature on Tyroglyphid mites, Lapage¹ directed attention to their role in pulmonary acariasis of man, in addition to destruction of stored food-products. The Oribatids are allied to these cheese- and flour-mites and to the well-known harvest- and chigger-mites, and have been, until a few years ago, of comparatively little economic significance. Otherwise known as moss-mites and beetle-mites, they have been studied for many years and from all over the world. They are mostly microscopic in size, free-living and terrestrial, although a few are aquatic and crawl on weeds. Their activity is greater in darkness, when they swarm out in search of food, and progression is

normally slow. They have a shiny chitinous body-wall, a wing-like extension (the pteromorpha) at the antero-lateral corner of the abdomen on each side, a pair of peculiarly shaped sense-organs (the pseudostigmatic organs), and no eyes.

By and large denizens of the soil, the oribatid mites occur in decaying vegetation, among fungal mycelia, moss or algae, and form a conspicuous group amid the soil biota. Some are confined to the soil and migrate on blades of grass during the night; others conceal themselves in the bark of trees or crawl on twigs and leaves. Depending upon their habitat, they are classified as terricolous, dendricolous, bryobious and humicolous.

In the group Acarina, which comprises parasites (Ixodoidea and Sarcoptidae), predators (Trombididae), and suckers of plant sap (Tetranychidae), the Oribatoidea are outstanding in being herbivorous or saprophagous. They feed on moulds (fungivorous), algae, decaying leaves or animal matter, and are distinctly inoffensive. Consequently, although systematists like Banks, Berlese, Nicolet, Michael, Oudemans, Jacot, Grandjean and Ewing have revealed the abundant and ubiquitous occurrence of these organisms, very few investigators attributed any importance to them. Michael², in his monograph, has remarked that none of the species is "injurious to man or his works". Jacot³ regarded them as "negative, humble and devoid of weapons of offense"; afterwards⁴, he commented on the occurrence of *Damcæosoma alces*, *Protoschelobates pembertonii* and *Xylobates pembertonii* in holes in cane roots, of *Lohmannia insignis* on bean seedlings and of *L. insignis dissimilis* on tulip bulbs as having no significance, because no evidence could be adduced that the holes were caused by the mites. He concluded that "the case against oribatides as non-injurious is becoming weightier".

Stunkard's⁵ experiments on the development of *Moniezia expansa* disclosed the identity of the intermediate host of this tapeworm. He announced that *Zetes* (*Galumna*) *emarginatus* harboured the cysticeroids of the worm to the infective stage, and this discovery heralded a series of publications on the life-cycles of other Anoplocephalid cestodes. The work of Krull⁶ (U.S.A.) on *Cittotænia* and *Moniezia*, of Stunkard⁷ (U.S.A.) on *Bertiella studei*, of Pullar⁸ (Australia) on *Moniezia*, of Bashkirova⁹ (U.S.S.R.) on *Anoplocephala* spp., and *Paranoplocephala mamillana*, of Potemkina¹⁰ (U.S.S.R.) on *Thysaniezia ovilla*, and of the present writer¹¹ (India) on *Moniezia expansa* and *M. benedeni*, has involved oribatid mites of various genera and species as the undoubted vectors of these worms. Moreover, the same species of mite is observed to be capable of conveying more than one species of the cestode in a locality.

The Anoplocephalid tapeworms, characteristically devoid of rostellar hooks, are among the worst enemies of livestock, and to the veterinary parasitologist the oribatid mite has therefore suddenly become of major importance.

¹ *Nature*, 156, 427 (1945).

² "British Oribatoidea", 1 (1884).

³ *Amer. Nat.*, 59, 272 (1925).

⁴ *Bern. P. Bishop Mus. Bull.*, 121, 93 (1934).

⁵ *Parasit.*, 30, 491 (1938).

⁶ *Proc. Helm. Soc. Wash.*, 6, (1), 10 (1939).

⁷ *Amer. J. Trop. Med.*, 20 (2), 305 (1940).

⁸ *Austral. Vet. J.*, 15, (2), 71 (1939).

⁹ *C.R. Acad. Sci. URSS.*, (N.S.) 30, (6), 576 (1941) (in English). *Vestn. Sel.-khoz. Nauk., Veterinariya*, No. 2, 57 (1941, in Russian, with French summary).

¹⁰ *C.R. Acad. Sci. URSS.*, (N.S.), 30, (5), 474 (1941); 43, (1), 43 (1944).

¹¹ Unpublished work.

THE MESON FIELD AND THE EQUATION OF MOTION OF A SPINNING PARTICLE

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THE outstanding difficulty in obtaining the equation of motion of a spinning particle in a meson field which will take account of the reaction of the emitted meson field and is free from singularities is well known. The equation of motion was first obtained by Heisenberg¹ for a dipole of finite extension and is therefore not relativistically invariant. The relativistically invariant equations of motion for a point dipole which have been developed by Bhabha and Corben² and by Bhabha³ are extremely complicated and involve a number of arbitrary constants which are not determined uniquely. These equations in their final form are free from singularities, and have been proved to involve only the contribution of the so-called radiation field, defined as half the retarded minus the advanced field, which is finite on the world line. However, the equations are established by proving that the singular terms are perfect differentials and can therefore be subtracted away.

In 1939, Riesz⁴ developed an elegant method for solving the differential equations of hyperbolic type in which the divergent difficulties are avoided by a process of analytical continuation. The method has been recently applied by Fremberg⁵ to obtain the classical equation of motion of a charged particle in an electromagnetic as well as in a meson field. Following Riesz, we shall define the potential and the field of a dipole for a parameter $\alpha > 2$ and show that the analytical continuation to $\alpha = 2$ gives the classical values corresponding to those of Lienard-Wiechert outside the world line, and a finite value on the world line itself giving the reaction of the field. The equations of motion of a point dipole can then be obtained in a straightforward way from the usual equation of a dipole as given by Frenkel⁶. The equations are free from singularities and do not contain any arbitrary constant except the spin angular momentum of the dipole.

We define the Riesz potential for the dipole at a point $P(x)$ outside the world line in the form,

$$\varphi_{\nu}^{\alpha}(P) = \frac{g_2 \chi^4 - \alpha}{2^{\frac{1}{2}}(\alpha - 2) \Gamma(\alpha/2)} \frac{\partial}{\partial x_{\mu}} \int_{-\infty}^{\tau_0} S_{\mu\nu}(\tau) (\chi s)^{\frac{1}{2}(\alpha - 4)} J_{\frac{1}{2}(\alpha - 4)}(\chi s) d\tau, \quad (1)$$

where τ is the proper time of the particle, τ_0 the retarded point of P , $J_n(x)$ is the Bessel function of order n and $g_2 S_{\mu\nu}$ is the antisymmetrical tensor describing the dipole moment. The four-dimensional distance s is given by

$$s^2 = s_{\mu} s^{\mu}, \quad s_{\mu} = x_{\mu} - z_{\mu}. \quad (2)$$

The integral converges for $2 < \alpha < 5$. The potential (1) satisfies the wave equation of a dipole in a meson field given by

$$\frac{\partial}{\partial x_{\rho}} \frac{\partial}{\partial x^{\rho}} \varphi_{\mu} + \chi^2 \varphi_{\mu} = 4\pi \frac{\partial}{\partial x^{\nu}} S_{\nu\mu}, \quad (3)$$

when we continue analytically to $\alpha = 2$.

Now it can be shown after some calculations that the analytical continuation to $\alpha = 2$ of the Riesz potential (1) and the corresponding field-strength for