also been used in gyroscopes and for similar purposes where high density combined with strength is necessary. The tensile strength of the sintered alloys is about twenty-two tons per square inch, but although they can be hot worked, they have very little ductility cold.

The largest application, however, is as a contact material for heavy-current circuit breakers. For this purpose, the alloy is applied as a facing brazed on to the copper contact arms. Contacts having a superficial area of about two square inches have been used successfully to break currents of 130,000 amperes at 6,000 volts. Tungsten has, of course, long been recognized as a useful contact material, owing to its low vapour pressure, but the pure metal could not be produced economically in the large sections required for high-power electrical engineering purposes.

[1] NATURE, **139**, 52 (1937).

The Starling in the United States of America

By Dr. Walter E. Collinge

THE dangers arising from the introduction of foreign species of animals have frequently been dwelt upon by zoologists of all nationalities. The results of such acclimatizations have nowhere been more pertinently summarized than by Palmer[1] in 1893.

The species to which we here wish to direct attention is the European starling (*Sturnus vulgaris* Linn.). Thirty-five years ago we possessed a very meagre knowledge of the feeding habits and economic status of this bird, and it was introduced into various countries in the belief that it was distinctly beneficial to the farmer and fruit-grower.

The earliest record I can find of its introduction into the United States is that made by the Acclimatization Society of Cincinnati, Ohio, which liberated a number in the winter of 1872–73. In 1877 the American Acclimatization Society liberated a number in Central Park, New York, and again in 1890 about sixty birds were released. In 1889 and 1892 thirty-five pairs are reported to have been released at Portland, Oregon. In April 1890 eighty birds were released in Central Park, New York, and forty more in March of the following year. Later, smaller numbers were liberated in different localities.

From these various importations the starling has increased and spread throughout the whole of the north-eastern States, and it is gradually spreading westwards. The extension of the range and the methods of spread have been fully dealt with by Mrs. Mary Thacker Cooke[2], while a fully detailed account of the food and feeding habits has been published by Kalmbach and Gabrielson[3]. To this latter I shall refer later.

Few seem to have regarded the starling as a potential danger to the United States. Writing in 1916, Forbush[4] stated, "Already the starling has begun to show a capacity for harmfulness which may be expected to become more prominent as its numbers increase. . . . Perhaps it is too early yet to say what will be the final result of the introduction of the starling into this country. Its value as an insect destroyer is plain; but its unchecked increase may prove a calamity to several species of useful native birds, and from the experience of other countries we may assume that it is likely to become a pest to the fruit grower."

In any attempt to arrive at the true economic position of this bird, we must not lose sight of the fact that it is a powerful animal with a strong and formidable weapon of defence in the shape of its beak. Moreover, it exhibits great powers of caution and intelligence.

A further point of interest is its great fecundity; it is exceedingly difficult to estimate even approximately the actual number of pairs of breeding birds in the United States; but for the purpose of illustrating the rate of increase, we will presume that in 1933 there were 200,000 pairs, and that each pair reared three pairs of young, half of each sex, and that all lived together with their offspring. The progeny and parents in a single year would total 1,600,000. At the end of 1934 this number would have increased to 6,400,000, the addition in 1935 would make the total 25,600,000, while at the end of 1936 there would be more than 102,000,000 birds.

These figures are calculated on the basis of a single brood per year, though in many parts of the country there are two broods. Even allowing for a very high rate of mortality, it is clear that the annual increase is enormous. Herein lies a potential danger which should not be overlooked.

Knowing how injurious this bird has become in Great Britain and also in Australia, New Zealand

and Tasmania, let us consider the nature of its food in the United States. An examination by Kalmbach and Gabrielson of 2,157 stomachs shows that 57 per cent of the food consists of animal matter and 43 per cent vegetable matter, and of this animal content 41·55 per cent is composed of insects. The full details are as follows: weevils 8·50 per cent, ground beetles 5·71 per cent, May beetles 2·24 per cent, other beetles 3·14 per cent, grasshoppers 12·41 per cent, caterpillars 6·04 per cent, millipedes 11·71 per cent, Hymenoptera, Hemiptera, Diptera and other miscellaneous insects 5·93 per cent, animal garbage 1·32 per cent, cultivated cherries 2·66 per cent, other cultivated fruits 1·75 per cent, wild fruits 23·86 per cent, grain 1·16 per cent, vegetable garbage 13·57 per cent.

In Great Britain, we obtain rather different figures: animal food constitutes 51 per cent and vegetable food 49 per cent. Of the former, 26·5 per cent consists of injurious insects, 2·5 per cent of beneficial insects and 3·5 per cent of neutral insects, 8·5 per cent of earthworms, 6·5 per cent of slugs and snails, 1·5 per cent of millipedes, and 2 per cent of miscellaneous animal matter. Of the vegetable food, 20·5 per cent consists of cereals, 2·5 per cent of cultivated roots and leaves, 15·5 per cent of cultivated fruits, 7 per cent of wild fruits and seeds of weeds, and 3·5 per cent of miscellaneous vegetable matter. Summarizing these figures, we find that 36·5 per cent of the starling's food constitutes a benefit to the agriculturist, 41 per cent an injury, and 22·5 per cent is of a neutral nature.

A brief comparison of the figures resulting from the above two investigations shows that in Great Britain the starling has taken to feeding upon cereals and cultivated fruits to a much greater extent than in the United States, and we have little doubt that as this bird increases in numbers a similar change in its feeding habits will take place in America.

There was a time, no doubt, when in Great Britain this bird was a most useful and beneficial one to the agriculturist, just as it is at the present time in Ontario[5], but once let it reach the high-water mark of abundance, and it becomes equally injurious. It is this fact which we wish to stress, for once this bird reaches the high-water mark it will prove a much more serious pest than the European house-sparrow.

By the enactment of wise repressive measures this calamitous state of things may be averted; but if the situation is not properly realized and things are allowed to drift, then the agriculturists and fruit-growers of the United States will suffer as seriously as, or even more than, those of Great Britain.

Writing in 1912, I stated[6]: During the first six months of the year the food in an urban district was distinctly of an insectivorous character, and the evidence from the food generally would lead us to place the species amongst those birds beneficial to the agriculturist and horticulturist, but a similar record extending over the same period taken in an agricultural district would, in all probability, reveal the starling as a destroyer of newly sown grain, and extended over the summer months, would show that it inflicts considerable losses upon fruit growers. As the result of further investigations, I was forced to the conclusion that "the starling has become a plague in the land and a source of great national loss".

It is a pity that this undesirable alien was ever introduced into the United States, but that is past history; what must be looked to at the present is to see that a very careful watch is kept upon this bird from all aspects, and that its numbers be strictly limited. For the information of how this may best be done American citizens may look with every confidence to their famous and unrivalled Department of Economic Ornithology in the Biological Survey.

[1] Year Book, U.S. Dept. Agric. for 1893, pp. 87–110.
[2] U.S. Dept. Agric., Dept. Circ. No. 336, 1–7 (1925).
[3] *U.S. Dept. Agric.*, Bull. No. 868, 1–66 (1921).
[4] Mass. State Bd. Agric., Circ. No. 45, 1–23 (1916).
[5] Lewis, Univ. of Toronto, Biol. Studies. No. 30 (1927).
[6] Second Rpt. Econ. Biol., 1912. pp. 65, 66.

A New Method in Biogeography

THE last two or three decades have witnessed great progress in the studies of ecological and geological factors of distribution of plants and animals, but the results of these studies have had little influence on biogeographers, whose work is still mainly concerned in the parcelling out of the globe's surface into regions, provinces, etc., characterized by statistical ratios of endemic forms and those common to several divisions. The methods of biogeographical work remain generally the same as in the time of Wallace, and a great proportion of literature (zoogeographical in particular) is devoted to discussions of the exact boundaries between formal divisions. When, however, two types of fauna or flora, different in their geological origin and adjusted to different ecological