6. "True return" percentage as calculated from the actual number of returns and the estimated size of population "in contact with nets" was 38% in 1956, 41% in 1957 and 26% for the two-year span, 1955-57. Thus, out of 100 birds wintering about 40 returned the next year and 26 of these survived to the third winter.

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MIST-NETS versus HELIGOLAND TRAPS

BY KENNETH WILLIAMSON

Some experimental use of Japanese mist-nets was made at Fair Isle Bird Observatory during the field-season of 1956. In addition to two large nets kindly donated by Mr. Alexander Bergstrom, three smaller ones from another source were also available. The purpose of this article is to report on the potentialities of this technique in ornithological studies on remote islands, and consider the relative merits of the nets and the permanent wire-netting traps on the Heligoland model which are standard equipment at all British bird observatories. The article has been stimulated by the appraisal of the various techniques and the results to be obtained from them given by Bergstrom and Drury (1956),—and especially by their statement: "We do not know of any full-scale Heligoland traps in use on this side of the Atlantic, and it is unlikely that any will be built as an alternative to mist-nets."

GEOGRAPHICAL SITUATION

Fair Isle is a rather small island (3½ x 1¼ miles) between the Orkney and Shetland archipelagos north of Scotland, and it is 25 miles from each. It therefore commands an extensive arc of seascape between northeast and south on the European side, and between southwest and north on the Atlantic fringe. It is treeless and lacking in any sort of cover except at the cultivated southern end, where there are small plots or "riggs" of oats, turnips, potatoes, and a few enclosed cabbagegardens. The northern two-thirds of the island is mainly *Calluna-Erica* heath, bounded by cliffs which reach to between 300 - 650 feet in the west and north.

CLIMATIC CONDITIONS

The island lies within the sphere of influence of the Atlantic storm-track and its weather is dominated by the frequent movement of depressions northeastwards towards the Icelandic "minimum." For much of the year, especially between September and May, it is wet and windy, the wind often at or above gale force. Calm clear days are infrequent and usually due to col conditions with the island placed between highs over Scandinavia and England and lows over the Iceland region and middle Europe or the North Sea. Such spells are of exceedingly brief duration,—"A day between weathers," the islanders say! Occasionally in summer the Azores high extends sufficiently far to the northeast to bring a longer spell of quiet weather, but such periods are not infrequently marred by atmospheric stability and resulting sea-fog.

THE MIGRATION

The island's potentialities as a migration study-centre were first revealed by Dr. William Eagle Clarke (1912), and his pioneer activities were continued by the Duchess of Bedford, Surgeon Rear-Admiral John H. Stenhouse, and later by Mr. George Waterston, who was mainly instrumental in founding the Bird Observatory in 1948. The island's geographical position and wide coverage of the surrounding seas, and the fact that it has powerful lighthouses at the northern and southern extremities, make it an ideal "staging-point" for

(a) Continental birds deflected by easterly weather from the short Skagerrak sea-crossing, or the coastal "leading-lines" between southern Norway and the Low Countries (Williamson 1952, 1955); and

(b) Northwestern migrants whose normal journeys to and from the Faeroe Islands, Iceland and Greenland pass through the British Isles (Williamson 1953).

In clear weather Fair Isle is visible from both Orkney and Shetland, so is a "stepping-stone" for diurnal movements of Shetland birds, or re-determined passage arising out of (a) and (b) above. It is also justly famous for the frequent visits of extra-limital vagrants, from regions as far apart as eastern North America and Siberia beyond the Yenesei.

TRAPPING AND BANDING

The studies undertaken by the Bird Observatory depend for their success on (a) observational work, estimating the species and numbers present on the isle at any one time, and (b) sampling the migrant flocks and local breeding passerines by means of trapping. For both activities the help of amateurs and students is needed and is greatly encouraged, hostel accommodation being provided by the Observatory.

Apart from such devices as "Potter" traps, clap-nets and the like, there are a dozen permanent wire-netting traps embodying the Heligoland principle. These may be discussed in four categories:

(i) Heligoland traps on the classical model (2),
(ii) "Gully" traps (2),
(iii) "Dyke" traps (3), and
(iv) "Ditch" traps (5).

In order to conserve time and energy it has been found convenient to build these traps (with one exception) in a fairly restricted area on the east side within a radius of a mile of the Bird Observatory. The construction of Heligoland traps has been dealt with in instructive detail by Brownlow (1952).

Type (i), with its wide entrance commanding open ground or natural cover, is not ideally suited to Fair Isle, or indeed to any island where rough weather late in spring and early in the fall covers the vegetation with salt spray. It was therefore found expedient to modify the design and construction of the traps to suit the terrain, and exploit to full advantage the natural behaviour of the migrant birds. The Gully and Vaadal traps (ii) consist of a wire-netting roof carried on girders or cables across a narrow defile, the upper end of which is closed with a funnel and catching-box. Such defiles provide shelter for the birds in rough weather, and are especially atrractive in the very early morning immediately following their arrival. The Gully trap, the most successful in point of numbers and variety of species caught, owes its success to the fact that it closes off the exit from a short stream-fed valley into which the coastal cliffs "funnel" the birds from north and east. It is the perfect natural site for migrant arrivals.

Not only do many migrants move on to the island's heath from the cliff-slopes in this way, but, once on the heath, they tend to concentrate along the course of the dry-stone walls or "dykes" which divide different portions of the scathald or outmark grazing. There is no doubt that these walls act as miniature "leading-lines," and on "rush" days hundreds of birds pass along them. Wheatears—of which we have

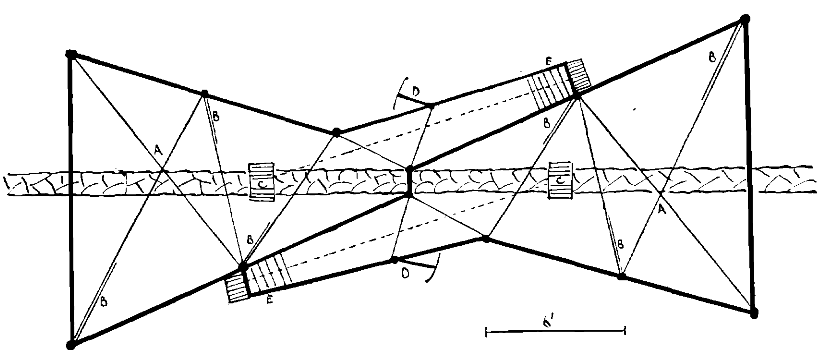

Fig. 1. Plan of Fair Isle "Double Dyke" trap. A, bracing wires or struts; B, wire-netting baffles; C, steps over wall; D, trapper's exit door; E, ramp and catching-box.

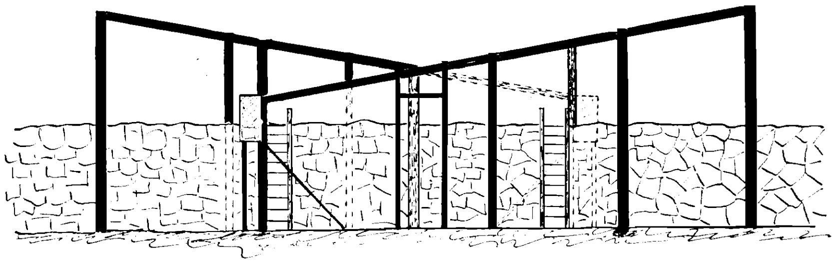

Fig. 2. Side elevation of "Double Dyke" trap.

trapped over 1,500 in the past 2 seasons—are particularly attracted to them, and also Redwings of the Iceland race (but not, curiously enough, the Scandinavian birds,—an intriguing difference in the behaviour of geographical forms). We have adapted the Heligoland principle to this situation and now have two double-ended and one single "Dyke" traps straddling these walls (Figs. 1 and 2), and could profitably use several more.

The "Ditch" traps are really ancillary to (iii): they are small structures placed at various points where a natural hollow or ditch runs alongside a wall. The most successful was designed as a two-way trap (Fig. 3). Since they do not actually span the wall, being of the same height, they do not catch as many birds; but they are a good deal more economic of labour and materials. A recent taxonomic and migration study of the Iceland Merlin by Butterfield (1954) and the present author (1954 b) was made possible only by the efficacy of these "Dyke" and "Ditch" traps.

In 1956 (end of March to mid-November) the Observatory banded a total of 3,300 birds of 80 different species, captured mostly in the traps. There are comparatively few days on which the total exceeds 40, and numbers beyond that tend to put an undue amount of pressure on work in the laboratory.

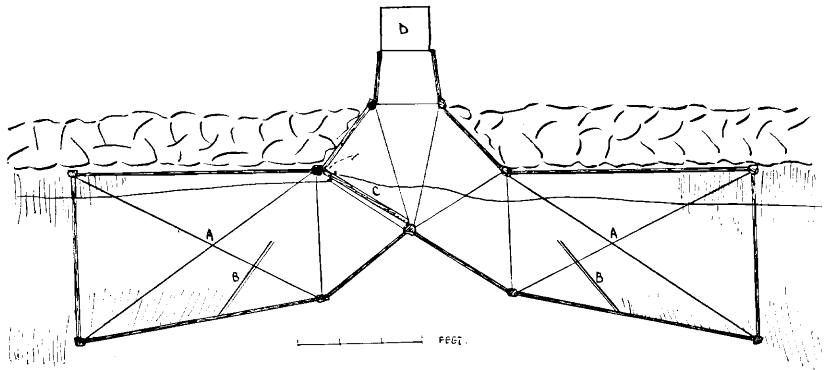

Fig. 3. Plan of small two-way "Ditch" trap at break in wall. A, bracing-wires; B, baffles; C, wire-netting door, with control line, hinged on centre-post; D, catching-box.

FIELD LABORATORY WORK

Trapped birds undergo a routine examination prior to being banded and released, the information for each individual being entered on a separate proforma. The information is later transferred to record systems (e.g., the "Ringing Register," "Moult" card-index, etc.) but the "lab. chits" are retained in datal order under species heads to facilitate statistical analysis of weights and measurements, or of seasonal infestation by parasites, later in the year. The data required will vary with different species and according to the particular demands of current work, but generally include:

(a) Racial segregation (for which selected cabinet specimens of the geographical races of most species likely to occur are kept at the Observatory through the courtesy of the Royal Scottish Museum).

(b) Age and Sex marks.

(c) Measurements of wing, bill, tarsus and tail-length in millimeters, these sometimes bearing upon (a) and (b) above. (The wing-measurement taken is the minimum chord when the primaries are placed flat in their natural curve, with the carpal joint resting against a brass stop at 0 mm. on the rule. When data from live birds have to be compared with skin material, or with records in the literature based on skins, in which a slight shrinkage occurs in the dried specimen, the minimum value is essential).

(d) Body weight—sometimes an important indicator of recent migrational history (e.g., an excessively low mean value in a sample will denote a protracted oversea flight, and may be a useful check against an analysis of the meteorological background of the movement).

(e) Wing-formula. (Usually for critical groups, such as the warblers, only: both wings should be checked and assurance obtained that the outer primaries are not completing moult).

(f) Full topographical plumage-description in the case of rarities, for submission with the published record.

(g) Moult, if any, in detail.

(h) Examination for ectoparasites.

"Repeat" trappings are weighed and measured anew. With local birds the latter gives an indication of continued growth in newly independent juveniles, and, in adults, the effects of abrasion or moult. The former may throw light on diurnal and seasonal variation in local birds, changes due to age, and (in the case of migrants) recuperation during an "off-passage" period. It may also be necessary to determine if re-infestation by parasites has taken place.

MIST-NETTING AND LABORATORY WORK

Most of the foregoing data are readily obtainable from birds whether they come from nets, or traps, or are captured alive in some other way. In some branches of Bird Observatory research, however, working with traps is preferable to using nets.

Observation. For assessing the kind of migration in progress (species and numbers taking part), freedom for wide-ranging observation is important. Both permanent traps and mist-nets limit one's activities—

the latter, however, much more severely than the former. The permanent traps at Fair Isle require a "round" of nearly 3 miles, partly along the coast, the rest across the heath and along the stone walls, and this course gives plenty of opportunity for making incidental observations. We found that using mist-nets restricted our movement to a very confined area since, unlike the traps, the nets cannot be left unguarded for more than a few minutes at a time.

Moult studies. A detailed history of the moulting sequence in any particular species requires the collection and arrangement of a large number of individual records (preferably with a sprinkling of repeat trappings). It was found that mist-nets are far from ideal for a study of this kind because in removing the bird, particularly if it is rather badly entangled, there is a marked tendency for old feathers (especially the important remiges and rectrices) to come adrift.

Ectoparasites. Our early ambition to put the study of ectoparasites on a quantitative rather than qualitative footing resulted in the development of a special apparatus in which the fleas, flies or Mallophaga can be anaesthetised with chloroform vapour (Williamson 1954a). This has placed at our disposal much new information concerning the general biology of bird-fleas at Fair Isle (Rothschild 1955), and has made possible a thorough study of the life-history and habits of the louse-fly *Ornithomyia fringillina*—secured largely through a program of paint-marking, releasing and recovering the flies (Corbet 1956 and in press).

Concentration on this branch of bird (and insect) biology, aspects of which would prove most rewarding at any bird-study station (and would provide valuable material for comparison with the Fair Isle results), demand a definite laboratory procedure. When a bird is trapped, it is removed from the catching-box and immediately placed in a linen bag, the mouth of which is sealed to prevent the escape of parasites. On arrival at the laboratory the bird is weighed whilst still in the sealed bag: it is then removed and quickly introduced to the collecting apparatus, some other person meanwhile taking the tare of the bag and scrutinising it for any parasites which may have left the bird's feathers during transit. (The bag should not be used again until it has been cleaned). When the bird has been treated the head is searched for ticks, after which species or racial determination, measuring and so on may proceed. It is imperative to follow this order of examination if quantitative results on host-specificity, seasonal frequency, etc., are desired.

Using mist-nets, it was found that the rate of loss of *Ornithomyia* was very great: sometimes flies were seen to leave the bird the moment it was handled, and on occasion several departed during the minute or more spent in disentangling the bird. It seems reasonable to suppose that other Hippoboscidae would behave in the same way, and there may well be a loss of fleas also. The rate of loss whilst "bagging" a bird at the catching-box, or transferring it to the apparatus in the laboratory, is exceedingly small, and indoors escaped flies and very often fleas can be recovered. If detailed and accurate studies are contemplated birds caught in mist-nets should be excluded from the program.

On the other hand, birds caught by this means should provide more reliable data concerning host-specificity and natural straying (due, for example, to phoresy) of Mallophaga, since the birds are isolated during capture. Occasionally transfer of Mallaphaga between two bird species will take place under the artificial conditions of confinement in a Heligoland catching-box.

MIST-NETTING VERSUS TRAPPING

The above objections apply universally, but they merely limit the scope of the mist-netting technique. In considering the island environment, it will probably be found that the main obstruction to a large-scale use of the nets is the climate. At Fair Isle there are not nearly enough days of calm or light air unmarred by mist or drizzle, and with a wind of force 4 or more the nets are not efficient, more birds escaping than are held. The general pattern of migration at Fair Isle is not likely to be very different from that on islands off the American coast, where falls of birds may also be fortuitous and due to the phenomenon of drift in adverse winds from coastal "guiding-lines" or short sea-crossings such as the Gulf of St. Lawrence or Bay of Fundy. As drift implies the temporary loss of navigational aids, such movements are very often the result of frontal disturbances, with winds fresh to gale; and although mist-nets could never be used under these circumstances, the permanent traps can still be worked with highly profitable results.

We experimented with mist-nets, when the weather and other things were equal, in four different types of situation: (a) incorporated with the usual trapping-round, (b) in the crops, (c) in a stubble-field, in the hope of getting a good series of Skylarks (which are not taken in the larger traps), and (d) in a variety of habitats for some specific purpose, such as the capture of a rarity which could not have been caught in any other way.

For general use (again with the proviso about weather) the ideal way of employing mist-nets at a place like Fair Isle is as an ancillary to the permanent traps. One can adapt them with some hope of success—as we have adapted the principle of the Heligoland trap—to the "leading-line" effect of the long dry-stone walls, erecting them at points where there is a temporary break. This was tried during a short period in August and gave some success with local Wheatears, Meadow Pipits and Starlings, the most productive site being in the mouth of a small disused quarry cut into the face of a hill where one of the walls abruptly changed direction. In such case one does not have to devote time to "sitting over" the nets, since they are visited at frequent intervals along with the rest of the traps, and they allow more freedom for movement and wider observation.

Nets were not successful in the crops of turnips and potatoes, though there seems no reason why they should not be effective on good days. Siting is the main difficulty, as the fields are generally devoid of good "background," and birds see the nets too easily. My daughter Hervør and I were working with nets in the Busta "riggs" on the afternoon of September 21 when a large pale grey shrike, of a kind entirely outside my experience, flew to the field and perched on one of the supports.

It was ridiculously confiding and we were able to approach to within a few yards. After looking at it for some minutes I thought it was probably *Lanius excubitor pallidirostris*, of which there was only one previous record for western Europe (at Utsira, Norway, on September 5, 1953), and which inhabits the arid country between the Caspian and Aral Seas. It was a "must," but try as we might we could not get it in the nets: it would descend to the crops periodically for insects, and despite all our tactical coercion would return with meticulous judgment to one or other of the supporting poles or their stays. Frustration mounted, and became almost unendurable when the shrike suddenly took wing and flew with deep undulations across several fields. Fortunately it came to rest in the vicinity of the Haa, where we have an orthodox Heligoland, and after a little manoeuvring we made sure of it there and were able to confirm this first British record in the lab. An unfair commentary, perhaps, on the value of mist-nets as compared with permanent traps; and if there's a moral, it is perhaps that one should have at least two strings to one's bow!

We found the same trouble in the stubble-field as in the crops—the situation was too open, and the nets too obvious to the birds. Indeed, the Twites could see them so well they ranged themselves in an impudent if precarious row along the top. The only way to catch them, and the Skylarks and Starlings which were feeding numerously in the field, was by "rushing" the nets when the birds were fairly close. On other days, with a moderate wind, the wind-pressure "bellied" the nets and kept the trammels too taut, so that there was insufficient vertical slack, and the bird's weight on striking failed to make a proper "bag." Too many were lost, including a young *flava* wagtail I had set my heart upon; but by way of consolation this day's work gave us a "repeat" Starling in its eighth year, first banded on Christmas Day of 1949.

Mist-nets have one very great advantage over stationary traps—you can carry them around in a pocket, and set them up in almost any kind of situation in a matter of minutes should the need arise. There are fairly frequent occasions on isolated migration-islands of the Fair Isle type when this feature of the nylon net is a real boon, and the mist-net should be as much personal equipment as field-notebook and binoculars. Desirable rarities or critical species often turn up in haunts far from the trapping-area and the mist-net may be the only practical means of effecting capture. Our first experience of this sort was on May 29, when a bird that was both rare and critical was found in company with Dunlins on a southern shore. It was provisionally identified as either *Ereunetes pusilla* or *E. mauri*, and a mist-net set up across the seaweed enabled us to get the bird and establish the first Scottish record of the Semipalmated Stint. A Bar-tailed Godwit and Sanderling were caught in similar fashion at a later date, but the rise and fall of the tide introduces a further complication when the trapping of waders is attempted by this means. Other rare and critical species required for certain determination, and which we could not have handled without recourse to mist-nets, were first-winter Reed and Wood Warblers in August; and during a migrant "rush" on September 7 three Red-spotted Bluethroats were netted at one site in half-an-hour.

SUMMARY

Fair Isle is too wet, windy and bare to promise notable success with Japanese mist-nets. In these respects it may prove similar to other exposed offshore islands in Europe and North America, particularly as the big falls of migrants at such places are often associated with low pressure weather in which mist-nets cannot be used.

Islands of this kind must rely primarily on well-built permanent traps on the Heligoland principle, the design of which can be modified in a number of ways to meet the special needs of the environment. These traps are productive in any weather and permit a greater freedom of movement for observational work.

For certain studies in field taxonomy, particularly quantitative studies of bird ectoparasites, birds from the traps afford the best material for accurate scientific results.

At island stations mist-nets can be used as an ancillary to the established trapping routine when time and the weather allow. Being portable, they are of great value in emergency, as when a coveted rarity or critical species appears in a haunt outside the trapping-area. For this reason a mist-net should always be carried.

SCIENTIFIC NAMES OF BIRDS MENTIONED

Wheatear and Greenland Wheatear: *Oenanthe oenanthe* and *Oe. oe. leucorrhoa.*
Scandinavian and Iceland Redwings: *Turdus m. musicus* and *T. m. coburni.*
Iceland Merlin: *Falco columbarius subaesalon.*
Skylark: *Alauda arvensis.*
Meadow Pipit: *Anthus pratensis.*
Starling: *Sturnus vulgaris.*
Steppe Shrike: *Lanius excubitor pallidirostris.*
Twite: *Carduelis flavirostris.*
Yellow Wagtail: *Motacilla flava.*
Semipalmated Stint: *Ereunetes pusilla*
Bar-tailed Godwit: *Limosa lapponica.*
Sanderling: *Crocethia alba.*
Reed Warbler: *Acrocephalus scirpaceus.*
Wood Warbler: *Phylloscopus sibilatrix.*
Red-spotted Bluethroat: *Luscinia s. svecica.*

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WEIGHTS OF WILD BOBWHITES IN CENTRAL MISSOURI

BY MAX HAMILTON

Existing publications on weights of bobwhites *(Colinus virginianus)* are based principally on data collected during fall and winter months, although Stoddard (1931) and Reeves (1954) presented some data for other seasons. This paper presents a series of 360 weights obtained throughout the year for 244 individual, wild bobwhites. The birds were captured on the University of Missouri's Ashland Wildlife Research Area in Boone County, central Missouri, during the period June, 1953 to June, 1954. With one exception, the weights were of live bobwhites.

The birds were caught in two types of traps: modifications of the cock-and-hen trap developed by Stoddard (1931) and a modified clover-leaf trap as described by Low (1951).

A grain mixture was used as bait during the fall, winter and spring, and in late spring and summer female bobwhites were used as decoys in trapping males, as described by Stoddard (1931:446-450).

All birds were weighed to the nearest gram on a dietetic spring scale. No restraining device was needed; each bird was placed on its back with the head hanging over the edge of the platform. In this position it lay quite still while the weight was determined.

The birds were marked with serially numbered aluminum leg bands. and released.

For analysis of the weights, the following three age-categories were used:

1. Juveniles: all young through completion of the post-juvenal molt; 0 to about five months of age.
2. First-year-adults: all birds which had completed the post-juvenal molt, but which had not replaced primary coverts in the first post-nuptial molt; about five months to 18 months of age. This category included birds breeding for the first time.
3. Adults: birds which had replaced the primary coverts in the post-nuptial molt; about 18 months of age or older.

For computation of average weights of age groups and of the two sexes, only the first weight of each bird was used, because several

[1]Contribution from the Missouri Cooperative Wildlife Research Unit: U. S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation and University of Missouri cooperating. The writer is indebted to T. S. Baskett under whose direction this study was made, and to C. P. Agee, P. W. Frank, and Wm. H. Elder.