

(a) "Thornbush," dominated by *Acacia* and *Commiphora*, of which few trees exceed fifteen feet in height; (b) what has often been called "savanna"—grassland swept by fire every year, and scattered with what in the dry season look like dead apple trees (the *Obstgartensteppe* of the Germans), with here and there clumps of semi-deciduous bush or of taller trees; (c) leguminous woodland, especially *Brachystegia*—*Isoberlinia* trees up to about sixty feet high, leafless for much of the year, and at all times throwing only light shade. Types (b) and (c) often include strips of more or less evergreen trees along the watercourses, and occasional great fig trees that are a prime attraction to some barbets. Type (c) and some of type (b) can be described as "well-wooded," but they are nothing like "deep forest."

A final point: specific and subspecific names of forms transferred from *Buccanodon* and *Tricholaema* to *Pogoniulus* and *Lybius* need to be given masculine endings in place of neuter.

*Amani*

*Tanganyika Territory*

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## SOUTHWARD INVASION IN GEORGIA

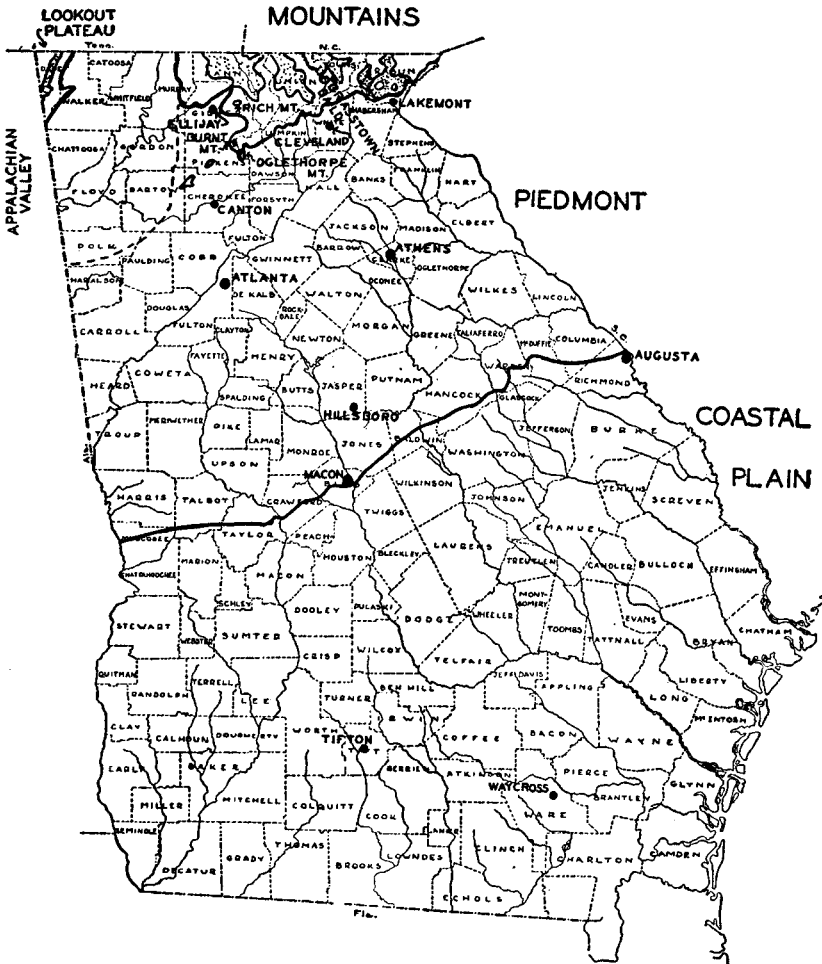
BY EUGENE P. ODUM AND THOMAS D. BURLEIGH

### *Plate 9*

THE extensive changes in natural conditions resulting from the spread of civilization in North America have naturally affected bird populations. Many species have been forced to retreat, and their abundance as well as their ranges have been greatly decreased. On the other hand, other species have profited by white man's alterations and have not only increased in abundance but in many cases have also extended their ranges. Because of the large amount of publicity given to vanishing species, bird students often forget the possible compensation provided by the advancing species. True, these latter are mostly small birds which do not have the glamour or popular appeal of such birds as Whooping Cranes and Ivory-billed Woodpeckers, but from the biological and economic standpoint they are equally worthy of study. When a species increases and invades new territory, it not only introduces a new and perhaps important factor into the biotic community, but speciation may also be affected since a new subspecies or species may eventually evolve in the new environment. In other words, just as artificial selection speeds up the evolution of domestic plants and animals, enabling man to learn something of the causative factors involved, so artificial changes in the environment speed up changes in natural populations, enabling

us to learn something of the forces at work in this particular aspect of evolution.

It is the purpose of this paper to discuss three recent examples of breeding range extension in Georgia, to analyze possible factors involved, and to list other species that may bear watching in the future. Some of the story of these invasions has been told in *The Oriole*, the journal of the Georgia Ornithological Society (see Literature Cited). Text-figure 1 is a sketch map of the state, showing the physiographic



TEXT-FIGURE 1.—Map of Georgia showing physiographic regions and localities mentioned in this paper. In the Mountain Region the stippled areas are the mountain valleys or plateaus (elevation 1600–2000 ft.) and the non-stippled areas represent the peaks and ridges which rise up to 4768 ft. elevation (Brasstown Bald).

regions and the specific localities referred to in the subsequent discussion. Georgia lies at the end of the main Appalachian chain which is a narrow but more or less continuous highway that 'funnels,' as it were, many northern species into the heart of the Southland. Some typically northern species do not breed all the way to the end of the mountain chain; a great many species occur to, or nearly to, the end but no farther; still others have spread out from the mountain ridges onto the hills and plains beyond. Because of its position at the tip of this great 'funnel' or 'salient,' Georgia offers an exceptionally favorable point for studying distributional evolution. Let us now consider specific cases.

ROBIN, *Turdus migratorius*.—The American Robin has been one of the most obvious beneficiaries of white man's civilization and one of the most spectacular invaders among native species. The breeding range of the Robin in eastern North America was probably a fairly restricted one when Columbus discovered America. Following a large increase within its original range, the Robin in recent years has extended its breeding range greatly in several directions and now is a common breeder in large areas where it was definitely unknown less than a generation ago. The Robin often has followed towns and farmlands, occupying, first at least, man-made lawns and shade trees, the habitat to which it became so successfully adapted in the Northeast. Such a change in distribution seems good evidence that the vegetational habitat was a critical, limiting factor in the original range of the Robin (*see* Odum, 1945c).

The story of the Robin as a breeding bird in Georgia is as follows. Prior to about 1910 the Robin was known only as an uncommon breeder in the mountain valleys of extreme northeastern Georgia (Text-fig. 1) and probably in some localities in the northern part of Appalachian Valley (Howell, 1909). The late Dr. W. H. LaPrade reported that the Robin first nested in Canton in 1905 and in Atlanta in 1914; these were the first records from the Piedmont Region. Between 1920 and 1930 the Robin spread rapidly over the Piedmont and sent spearheads well into the coastal plain. At Athens, where Burleigh was engaged in intensive field work, the Robin was entirely unknown as a breeding bird prior to 1927. In 1925, for example, Burleigh wrote that in Athens the Blue Jay "in many ways . . . replaces the Robin, which of course is lacking here in the summer months" (Burleigh, 1925b). In 1927, Mr. J. C. Jester showed Burleigh the first nest of the Robin to be found in Athens; it was in a shade tree in a residential section of town and contained eggs on

May 7. During the next few years the species nested in various parts of town and on the campus of the University of Georgia, gradually increasing in numbers. At present it is almost as characteristic a bird in residential areas as it is in a typical New England town. Other North Georgia towns and cities were similarly invaded. In Augusta, 90 miles southeast of Athens and nearly 150 miles from the mountains, the Robin first nested in 1929 (Murphey, 1937). In Macon, the first definite breeding evidence was obtained in 1932, but the Robin probably nested there two or three years previously (J. Fred Denton, personal communication). From these dates, it would seem that the occupation of widely scattered points in the Piedmont occurred within a very short time. As far as we know at the present time, the Robin nests in all large towns and cities in the 18,000 or so square miles of the Piedmont region, but (and this is a point we shall come back to later) apparently it does not occur in the rural areas and is only beginning to occupy smaller towns. For example, the Robin first nested in the little town of Hillsboro, Jasper County, north of Macon, in 1945, according to Mr. J. S. Anderson. It has not been detected in Jones County, which has no large towns even though adjacent to Macon, where the Robin has been established for ten years or more (Raymond J. Fleetwood, personal communication).

In 1937, a nest of the Robin was found in Waycross, which is but a few miles north of the Florida line (Flagg, 1937). This is the southernmost record that we have at the moment. There is also a definite nesting record at Tifton. Whether the Robin will successfully occupy the Coastal Plain as it has the Piedmont remains to be seen.

It should be pointed out that these Georgia-nesting Robins apparently belong to the southern subspecies, *achrusterus* (as indicated by specimens taken at Athens); in other words, they are not northern Robins which failed to migrate north, but birds spreading southward from the southern periphery of the specific range, which before 1910 was in and around the tip of the Appalachian backbone.

SONG SPARROW.—The Song Sparrow has invaded southward more gradually than the Robin, but the new territory occupied has been extensive. The southern border of the range of *Melospiza melodia* is two-pronged, with one population (*atlantica*) extending down the coast to Beaufort, N. C., and another population extending down the Appalachian backbone. The coastal population apparently has been static for many years, but the mountain birds have been actively advancing. Prior to 1885 the Song Sparrow did not nest anywhere in western North Carolina; at least William Brewster and Elliott Coues—

eminent field men—failed to find them (Pearson, Brimley, Brimley, 1919). Between 1885 and 1900, Song Sparrows began nesting in the mountain valleys of northwestern North Carolina and gradually spread southwestward, first reaching Murphy in Cherokee County, at the extreme tip of the state, about 1910, according to records kept by C. S. Brimley. Thus, the species pushed southwestward about 175 miles in less than 25 years. Song Sparrows did not nest in Georgia when Arthur H. Howell worked the extreme northeastern part in the summer of 1908; at least he did not record a single individual (Howell, 1909). In 1922, Burleigh (1925a) found the Song Sparrow breeding in Rabun, Towns, Union, and Fannin counties, where the mountain valleys are directly connected with those of North Carolina. The species subsequently increased noticeably in numbers (Burleigh, 1927), and at present even the most casual observer could scarcely miss seeing or hearing it in any of the three mountain valleys. As indicated in Text-figure 1, these mountain valleys (in reality they are 'plateaus,' having an elevation of 1,600 to 2,000 feet) are separated from the Piedmont region of the state by a rather formidable barrier, the Blue Ridge. It might be expected that this barrier would halt or at least slow down the invasion, since birds would have to find their way through gaps or over high, forested ridges in order to reach suitable habitat to the south. During the summer of 1945 we made a special effort to find out if the species had actually reached the Piedmont. Driving north from Atlanta, we first encountered Song Sparrows at Ellijay, Gilmer County, and collected a juvenile not long out of the nest. Farther east the species was singing and evidently breeding at Cleveland, White County. Finally, Mr. Glenn Bell has reported a nest from Lakemont. A line drawn connecting these points approximately represents the present 'front.' All three of these localities are south of the Blue Ridge (Text-fig. 1) and have altitudes of less than 1,600 feet. Therefore, the Song Sparrow has actually gotten out of the mountain valleys and become established on the northern edge of the Piedmont. Since there are no further physiographic or habitat barriers to the southward, it will be interesting to watch the species closely during the next few years. In the meantime, the Song Sparrow has already begun to invade the North Carolina Piedmont, probably moving eastward from the mountains. Since 1941, nests have been reported at Statesville, Winston-Salem, and Greensboro (information furnished by C. S. Brimley), the last locality a long way from the mountains. It would seem logical to predict that the Song Sparrow will soon be nesting in Atlanta and Athens, but only time will tell.

An interesting taxonomic problem is posed by the invasion, since two distinct subspecies may be involved. Birds which have entered Georgia are apparently *M. m. euphonia*. Those invading the North Carolina Piedmont are probably of the same variety but may be *M. m. melodia* (Pearson, Brimley, Brimley, 1942). The unstable situation should provide an unusual opportunity for studying the effects of changing populations and new environments on a notably plastic species.

CHESTNUT-SIDED WARBLER.—*Dendroica pensylvanica* is another species which apparently did not breed anywhere in Georgia prior to 1910 but which has since made a rather spectacular entry into the state. Howell in 1908 did not record a single individual on any of the high peaks which he visited, namely, Oglethorpe Mountain, Rich Mountain, and Brasstown Bald (see Text-fig. 1). In 1925, Burleigh (1927) found the species to be fairly common on Brasstown Bald, mostly above 4,000 feet, and found the first nests to be reported in the state. Since that time the Chestnut-sided Warbler has moved down to lower elevations and has apparently followed the ridges southwestward, since in June, 1945, we found it common about the tops of Burnt and Oglethorpe mountains<sup>1</sup> (3,000 to 3,300 feet) in Pickens County where the Blue Ridge comes to a rather abrupt end (Text-fig. 1). On June 23, Odum made a strip census along the ridge connecting Burnt and Oglethorpe mountains and found the Chestnut-sided Warbler by far the commonest and most conspicuous bird in the scrubby thickets growing under blighted chestnuts. On the slopes it occurred down to 2,600 feet (Odum, 1945a, b). It hardly seems possible that Howell could have missed so conspicuous a bird when he visited this same area in 1908, had it been present; therefore, it seems clear that this is new territory for the species. Unfortunately, we have no way of knowing just when it appeared here, since ornithological observations in this part of the state have been few during the intervening years. Since the Chestnut-sided has followed the high ridges rather than the valleys, it would seem logical to conclude that the invasion will stop at its present point, the end of the high ridges—but again time will tell!

ANALYSIS OF THE INVASIONS.—While the range boundaries of most species usually fluctuate somewhat from year to year as a result of minor invasions and retreats, rapid and extensive changes are not expected unless there are drastic changes either in the species itself

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<sup>1</sup> Mt. Oglethorpe, formerly known as "Grassy Mt." (on old topographic sheets), is the southernmost peak exceeding 3,000 ft. in elevation in eastern North America, and is the southern terminus of the famous Maine to Georgia Appalachian Trail.

or in the environmental limiting factors. As far as we can determine, the complicated machinery of mutations and natural selections, by which species are believed to change, proceeds very slowly indeed; many years are required to produce even small changes in basic morphology and physiology. Therefore, our attention is focused on the rôle played by changed environments. Furthermore, since climates have not changed recently, a change in habitat or biotic community would seem to be the most likely cause of the rapid-type invasions such as are described in this paper. (The activities of man may be causing climates to become slightly warmer and drier; this might be a factor in the northward spread of southern species but certainly would not aid the southward invasion of northern species as described here.)

There would seem to be three prerequisites for such invasions, as follows: First, the prospective invader must be able to tolerate the climate outside its original range; that is, climate must not be the critical limiting factor in the direction of invasion. Secondly, suitable habitat, previously unavailable or present in too small a quantity in the prospective new territory (hence a limiting factor), must be increased to a large enough volume for the species to gain and maintain a foothold. Finally, sufficient population pressure within the original range would seem to be necessary to encourage birds to occupy the new territory. The first two conditions would seem to be obvious, and require no elaboration. The third condition is partly assumption. Life-history studies have shown that individual birds are remarkably 'conservative' or 'traditional,' even though possessed of great powers of movement, and tend to return to, or remain within, the same area year after year. After the first breeding season, both the homing urge and the homing ability are generally good. Birds of the year may be more adventurous and seek new territory, but even the young of some species may return in a large degree to their birthplace as recently reported in the case of the Robin (Farner, 1945). If the population is relatively stable, few individuals would have an occasion to seek new territory far from traditional haunts. If, on the other hand, the population is rapidly increasing, individuals might be encouraged to spread if they can.

The Song Sparrow and Chestnut-sided Warbler invasions seem to have been fairly slow and gradual so far, with the breeding birds following natural physiographic features such as mountain ridges and valleys. In the case of the Song Sparrow, the invasion of the Piedmont apparently has begun only after the mountain valleys were



OGLETHORPE MOUNTAIN, GEORGIA. SLOPE NEAR THE SUMMIT SHOWING DENSE THICKETS WHICH HAVE REPLACED THE CHESTNUTS KILLED BY THE BLIGHT (IN BACKGROUND). IN THE FOREGROUND NOTE THE CHESTNUT SPROUTS PERIODICALLY KILLED BACK TO PRODUCE A SHRUB LIFE-FORM.



thoroughly occupied. The Robin invasion has been somewhat different, more analogous to an 'airborne' invasion of modern warfare; that is, rather widely scattered points (towns) were occupied within a few years, leaving intervening areas (rural areas) so far unoccupied. All three invading species have one very important thing in common: all nest in early seral or developmental stages of vegetation (or the artificial equivalents) of types that had been increased tremendously prior to the invasion. As pointed out elsewhere (Odum, 1945c), man reduces the sharp differences between natural areas both by establishing a rather uniform 'forest-edge' habitat in the vicinity of his dwelling and by generally increasing the quantity of developmental vegetation at the expense of the mature or climax vegetation. Species which are adapted to early developmental communities and which have wide climatic tolerance are thus encouraged to spread. As a rule there is some delay between the time wholesale habitat changes occur and that when a species begins to move into entirely new territory. In the case of the Robin, for example, lawns and shade trees were widely established in northern Georgia some years before the Robin actually began to occupy them. This would seem to be explained by assuming that the new habitat within the original range was occupied first and that only after a series of highly successful breeding seasons had produced a large surplus of birds did the rapid occupation of new territory begin. The slaughter of Robins on their wintering grounds in past years may also have been a factor in delaying the invasion. In other words, it seems clear that wholesale changes in habitat are directly responsible for each of the invasions described here, even though habitat selection and habits of the three species differ in a number of ways.

Let us examine the Robin's special case. Before colonization of eastern North America by the white man, the best Robin habitats were probably natural meadows, grassy forest edges, and open forests with scant undergrowth. Such situations were certainly most abundant under original conditions in northern and middle eastern North America. Large areas of tall grass prairie to the west and the oak and pine forests to the south would seem to have offered very little Robin habitat—at least the Robin had not been able to establish itself in these areas. During the last hundred years, man has provided huge areas of suitable habitat both in the original range and in adjacent areas. The invasion into Georgia is especially interesting since it shows rather clearly that the Robin is indeed somewhat specialized in regard to habitat selection. As mentioned before, the

Robin has so far occupied only the cities and towns and apparently the larger ones first. Here the bird finds large areas of lawns and shade trees very much to its liking. Rural areas in this part of the country consist of cotton and corn land, bunchy tall broomsedge grass, and open pine and oak forests with a large amount of undergrowth; none of these habitats seems to be liked by the Robin. Farm homes and those in small villages generally do not have lawns or very much shrubbery. As the Robin becomes firmly established in the cities, it might gradually work out into the submarginal or isolated areas available in rural areas. Also, rural areas in Georgia are undergoing change. Much cotton and corn land is being planted with cover crops and grass. As the erosion and tenant farmer evils are checked, more interest will be taken in lawns and plantings around dwellings, benefiting both man and the Robin. It will be interesting to watch these changes. The really remarkable feature of the Robin invasion is that the birds were able to jump over unsuitable rural areas and occupy widely scattered cities within such a short space of time. The only way we can explain it is to assume that there must have been a tremendous build-up of population to the north, thus providing thousands of birds which were forced, or at least encouraged, to seek new territories. The invasion seems to have been temporarily stopped or slowed down at the edge of the Coastal Plain. Perhaps another build-up in population will precede the next push, or perhaps further southward extension will be gradual. Also, conditions are rather different on the Coastal Plain. Towns are fewer and smaller; large areas of unbroken pine flatwoods and swamps in the southern part of the Coastal Plain would not seem to offer congenial breeding habitat for the Robin. Also, it must be remembered that climate might replace habitat as the critical limiting factor at any point, especially at the transition between natural regions. Nevertheless, the nesting records at Waycross and Tifton show that the species is at least attempting occupation of the Coastal Plain. Perhaps some day, Robins will be nesting in Miami, Florida!

Perhaps even more than the Robin, the Song Sparrow is a bird of wide climatic tolerance but with, by comparison, relatively restricted habitat requirements. Nesting Song Sparrows favor bushy growths that commonly occur as early stages in many seres, or artificial equivalents planted and maintained by man in the vicinity of his dwellings. The species is especially partial to bushy vegetation in the vicinity of water. The Song Sparrow had worked down the coast along a narrow strip of natural vegetation of a scrubby life form on the dunes

and salt marshes, nesting largely within the sound of the surf. With the breaking up of the continuous forests of the mountain region and the establishment of clearings in the stream valleys, favorable conditions for the Song Sparrow on a large scale were created, and the bird has not failed to take advantage of them. Small-scale farming practices in all of the upper South are very favorable to the Song Sparrow, since both stream borders and fence rows bordering on cultivated fields or pastures are almost always left with a good strip of weeds and bushy vegetation. Once the Song Sparrow was well started down the Appalachian backbone, it would be expected that the bird would eventually occupy all of the mountain region. This phase of the invasion has been completed during the past few years. The question then is: will the Song Sparrows continue on into the Piedmont where the climate and the plant and animal communities are rather different, but where plenty of stream-side and upland habitat is available? It is too early yet to venture a definite conclusion, but the Song Sparrow has definitely begun the invasion of the Piedmont both eastward in North Carolina and southward in Georgia.

The Chestnut-sided Warbler is far less widely distributed than either the Robin or the Song Sparrow, being largely restricted to the ecotone between the Eastern Deciduous Forest and the North Coniferous Forest (or part of the eastern half of the Transition Zone of Merriam). However, the fact that the bird has invaded new areas indicates that factors other than climate were involved in restricting the original range boundaries. Again, as in the cases of the Robin and the Song Sparrow, wholesale changes in habitat would seem to be the immediate cause of the southward invasion.

Proceeding southward along the Appalachian Mountains from Virginia and North Carolina to Georgia, the mountain peaks and ridges become lower and more scattered. Under original conditions, the Chestnut-sided Warbler habitat was undoubtedly scarce and isolated on the southern end of the backbone, since both slopes were generally covered with a heavy forest. Isolated natural 'balds' of scrub vegetation, occasional dry ridges, and perhaps some slopes burned over by fires started by lightning and Indians would provide the only suitable habitat. At least, the bird apparently was not able to gain a foothold in this region, where climate may also have been approaching a critical point. The original situation has been rather radically changed, not only by lumbering and fire, but more especially by the chestnut blight which has leveled every large chestnut tree in these vast forests, where the chestnut once composed a good

50 per cent of the dominants over large areas. Plate 9, a photograph taken near the summit of Mount Oglethorpe, shows the gaunt, dead chestnuts, many still standing, and the dense thickets that have replaced the forest. This picture is typical and could be duplicated over thousands of square miles of high ridge country throughout the southern Appalachians. The chestnut is down but not out; as soon as a tree is dead, copious sprouts appear at the base and grow quickly upward, only to be killed before reaching an appreciable height and to be quickly followed by new sprouts. Even with the blight, the chestnut is able to maintain itself as a partial ecological dominant, since the sprouts are often so vigorous that they shade out competitors (*see* Plate 9). Thus the blight has produced a sort of semi-permanent disturbance climax (or 'disclimax') which Brooks (1940) has called the "Chestnut Sprout Association." This shrubby vegetation is entirely different from the original forest and provides ideal habitat for thicket-loving, 'early seral' birds such as Towhees, Brown Thrashers, Catbirds, Indigo Buntings, Yellow-breasted Chats, and the Chestnut-sided Warbler, all of which were very much in evidence at the site shown in the photograph. It would be hard to estimate how many acres of territory formerly unsuited to the Chestnut-sided Warbler (and the other species mentioned) have been made suitable, but figures would no doubt run into millions. Presumably, as in the case of the Robin, the warbler first increased within its original range; then, when population pressure developed, it spread southward along formerly unoccupied ridges following the broad highways provided by the wholesale vegetative changes. It might be noted in passing that more local and less spectacular invasions of other species may also have resulted. For example, the presence of Chats on the very tops of Georgia's highest peaks probably represents an upward invasion favored by the production of large bands of suitable habitat extending from base to summit.

The chestnut blight first began to make itself felt in Georgia about 1900. By 1920, most of the large trees were dead and the undergrowth and sprouts increased accordingly. At about this time the Chestnut-sided Warbler first appeared in northeastern Georgia as a breeding bird. In general, the blight has been considered one of nature's great tragedies, since some very fine timber was completely wiped out. For the Chestnut-sided Warbler (and other species), however, it was a great windfall. Another interesting feature of this change is that it was the result of a biotic factor not directly caused by man (in fact, man did everything possible to prevent the

spread of blight). Even the short lifetime of an individual may not be too short to observe significant natural changes of evolutionary importance. One wonders how many times in ages past a similar natural catastrophe has influenced the affairs of species by aiding some to spread and by forcing others to retire, perhaps to the point of extinction.

**OTHER INVADERS.**—The three species discussed are by no means the only ones which have shown definite tendencies towards southward and eastward invasion in the southeast. Unfortunately, knowledge of past distribution is so poor in this region that only the most spectacular changes in distribution can be detected. The phenomenon of invasion serves to emphasize the value of careful local studies and local lists which give data on abundance, status, and habitat selection of the common as well as the rare species. If we were to follow accurately distributional changes in the future we must have a more accurate knowledge of present distribution. As far as Georgia is concerned, the following three species, especially, may bear watching in the near future.

**HOUSE WREN.**—The House Wren has extended its range southward very recently, having made a rather rapid invasion of the North Carolina Piedmont beginning about 1922 (Pearson, 1934). Previously, the bird was entirely unknown as a breeding bird in this state. The invasion was similar to that of the Robin in Georgia in that widely scattered towns were occupied in a short space of about ten years (*see* Pearson, Brimley, Brimley, 1942). We have been on the lookout for the House Wren in Georgia especially during the past breeding season (1945), but have found no sign of it. If the House Wren does invade Georgia it will be interesting to see if it enters via the mountains, where Bewick's Wren breeds, or the Piedmont, where Bewick's Wren does not nest.

**PRAIRIE HORNED LARK.**—The Prairie Horned Lark has been gradually moving eastward and southward, starting from the original home in the natural grasslands and occupying the very extensive man-made grasslands in the Eastern Deciduous Forest Region. Like the Robin and Song Sparrow, the Horned Lark is a bird of very wide climatic tolerance, breeding from the desert to the tundra. With removal of the forest barrier (another example where habitat was a limiting factor in the original range) it has spread into new areas. In the northeast, the lark has already reached the coast. In the southeast it has been detected breeding in North Carolina and recently in northwestern Alabama (McCormack, 1943). Consequently, it may soon be added to the list of the breeding birds of Georgia.

MOUNTAIN SOLITARY VIREO.—*Vireo solitarius alticola* is characteristic of, and generally restricted to, the Appalachian backbone, but some time in the unrecorded past the species has spread across the entire Piedmont Region of North Carolina at least as far east as Raleigh. In Georgia the Solitary Vireo is still pretty well restricted to the mountains but recently we have observed it in summer on the upper edge of the Piedmont at very low elevations. The Piedmont birds (both in North Carolina and in Georgia) seem invariably to choose fairly mature but hot and dry pine woods for nesting, a rather striking contrast to the cool, usually deciduous, ravines occupied in the mountains. As has been pointed out by Brooks (1942) habitat selection of some species is rather radically different at the periphery as compared with the bulk of the range. The 'marginal adaptation' to a new habitat may be an important factor in the invasion of some species. Invasion as result of a change in habitat selection is rather different from the invasions which we have been discussing where a species simply occupies newly created habitat without a basic change in habitat selections. Since the former implies some change in the bird itself, we may expect invasion of this sort to progress very slowly. The Solitary Vireo may be a good species to watch in the future even though very rapid changes probably are not to be expected.

SUMMARY.—The Robin, Song Sparrow, and Chestnut-sided Warbler have extended their breeding ranges southward during the past 35 or 40 years. Prior to 1910, the Robin nested only in the extreme northern part of Georgia and the other two species were entirely absent as breeding birds. At present the Robin has occupied all of the Piedmont Region and has nested in several places in the Coastal Plain. The Song Sparrow is well established throughout the Mountain Region and has very recently begun invading the Piedmont both in Georgia and in North Carolina. The Chestnut-sided Warbler now nests abundantly along the high ridges of the Mountain Region of Georgia as far south as Oglethorpe Mountain, Pickens County, where the Blue Ridge comes to an abrupt end. Since all three species breed in early seral or developmental stages of vegetation of types greatly increased by civilization, it seems likely that wholesale vegetative changes are directly responsible for these and other spectacular, rapid invasions. The Robin has occupied widely scattered cities and towns but not, as yet, the intervening rural areas where suitable habitat is lacking under present agricultural practices. The Song Sparrow invasion resembles a pincers movement since, in addition to the mountain valley invaders, a population (*atlantica*) has followed a narrow strip of natural vegetation of shrubby life form on

the coast. The latter population, however, has shown no recent evidence of expansion. The Chestnut-sided Warbler invasion seems clearly correlated with the chestnut blight which has rendered thousands of acres of high ridge country into a sort of 'chestnut sprout disclimax,' a habitat well suited to nesting needs of this and other species. As far as Georgia is concerned, the House Wren, the Prairie Horned Lark and the Mountain Solitary Vireo are additional species showing invasion tendencies that may bear watching in the future.

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