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HISTORY AND ANALYSIS OF TETRAONID INTRODUCTIONS INTO NORTH AMERICA

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Abstract: There has been considerable interest in the acclimatization of Old World Tetraonidae into North America. Between 1883 and 1950, 23 trials encompassing four species are recorded. Of these, 12 were releases of capercaillie (*Tetrao urogallus*) and 10 of black grouse (*Lyrurus tetrix*). Only one of these attempts was based on any scientific study, and none met all of the requirements currently considered to be the minimum necessary for an adequate test. All ended in failure. Source of stock, number of individuals released, their physical condition, and the year of liberation in relation to the cyclic abundance of grouse, both in the region of release and in the native range from which the stock was secured, are discussed. A description of habitat characteristics, food preferences, and climatic conditions in the range of capercaillie and black grouse in Europe and Asia is presented to facilitate comparison with conditions existing in the regions in which these species were released. Of 40 genera of plants commonly taken as food by these grouse, all are found in the United States. Average maximum and minimum temperatures in relation to precipitation, analyzed by months for the European range of capercaillie and black grouse, when compared with similar data for much of the northern United States and Canada, suggest a close relationship.

Since very early times, the holarctic distribution, abundance, and value of the Tetraonidae for food and sport have assured them a high place among the game birds of the world. There are 5 genera, 9 species, and 54 subspecies of grouse resident in Europe and Asia (Peters 1934:24-42) including the magnificent capercaillie, the black grouse, the hazel hen (*Tetrastes bonasia*), and the ptarmigans (*Lagopus* spp.), two of which are circumpolar in distribution. In North America, 7 genera, 11 species, and 46 subspecies are found.

It is to be expected, then, that settlers in the New World, finding country that ap-

peared similar to that occupied by grouse in Europe, would attempt to acclimatize these birds. Four species, the giant capercaillie, the black grouse, the hazel grouse, and the willow ptarmigan (*L. lagopus*), have been introduced, usually in small numbers. None has succeeded in establishing itself.

HISTORY OF TRIAL INTRODUCTIONS

Records of most trial introductions into America are fragmentary. Palmer and Oldys (1904:15) mentioned several early releases. Phillips (1928:2-4, 12-14, 18) commented in some detail on the earlier

Table 1. Recorded introductions of Tetraonidae into North America.

SPECIES	WHEN INTRODUCED	WHERE INTRODUCED	BY WHOM	SOURCE	NUMBER	STOCK	PHYSICAL CONDITION	REPORTED RESULTS
Caper-caillie	1893	Rhode Island	B. F. Stillman	Sweden	2	Wild-trapped	?	Disappeared.
	1895	Northern Maine	?	Sweden	4	Wild-trapped	?	Disappeared.
	1900	New Hampshire and Vermont	?	?	?	Wild-trapped	?	Disappeared.
	1903	Algonquin Park, Ontario	Provincial Government	Sweden	57	Wild-trapped	?	Some birds wandered long distances. Some possibly seen after 5 years.
	1903	?	Private Club	Sweden	8	Wild-trapped	?	Disappeared.
	1904-05	Grand Island, Michigan	Cleaveland Cliffs, Iron County	?	201	Wild-trapped	?	Four broods of chicks reported. All disappeared within a few years.
	1906	Litchfield Park, Hamilton County, New York	E. H. Litchfield	?	About 12	Wild-trapped	?	Disappeared.
	1906	Bay Pond Preserve, Franklin County, New York	William Rockefeller	?	85	Wild-trapped	?	Disappeared.
	1906	Nehasane Park, Hamilton County, New York	W. S. Webb	?	About 100	Wild-trapped	?	Disappeared after a few years.
	1906	Mainland near Vancouver, British Columbia	?	?	22	Wild-trapped	Poor	Put out in small groups. Disappeared.
Black Grouse	1907	Whitbourne, Newfoundland	Sir Robert Bond	Probably Sweden	23	Wild-trapped	Good	Disappeared.
	1949-50	Outer Island, Wisconsin	Wisconsin Conservation Commission	Sweden	21	Hand-reared youngsters, 8-10 weeks old	Good to poor	Disappeared after a year or two.
Black Grouse	1886	Newfoundland	R. Langrishe-Mare	Scotland	80	Wild-trapped	?	Survived for several years.
	1895	New Sweden, Maine	W. W. Thomas	?	Small	Wild-trapped	?	Disappeared.
	About 1900	Litchfield Park, Hamilton County, New York	E. H. Litchfield	?	6	Wild-trapped	Poor	Disappeared.
	1903	Algonquin Park, Ontario	Provincial Government	?	?	Wild-trapped	?	Disappeared.
	1904-05	Grand Island, Michigan	Cleaveland Cliffs, Iron County	?	58+	Wild-trapped	?	Disappeared.

attempts at acclimatization. Bump (1940:412) listed those for New York State, Ruhl (1941:427) one for Michigan. The more recent Wisconsin trials are described by Keener (1955). A summary of all these is presented in Table 1.

INTERPRETATION OF THE RECORD

The success or failure of a species in a new environment is determined by many factors. Some, such as habitat, climate, food and water, general habits, and repro-

ductive capacity, are characteristic of a species. Others are associated with the actual attempt at introduction. Among these are the suitability of the release area, the source from which the birds came, their age at release, their physical and psychological condition, the number of liberations attempted, the number of birds involved, and the time and method of release. While exact proof is lacking, the probability is that successful introductions occur only when all or nearly all these

Table 1. (Continued).

SPECIES	WHEN INTRODUCED	WHERE INTRODUCED	BY WHOM	SOURCE	NUMBER	STOCK	PHYSICAL CONDITION	REPORTED RESULTS
	1906	Vancouver Island, Saturna Island, Mainland near Vancouver, British Columbia	?	Denmark	46	Wild-trapped	Poor	Disappeared.
	1906	Bay Pond Preserve, Franklin County, New York	William Rockefeller	?	18	Wild-trapped	?	One brood raised. One male seen 1907, one about 1912.
	1906	Nehasane Park, Hamilton County, New York	W. S. Webb	?	A few	Wild-trapped	?	Disappeared.
	1906–07	Whitbourne, Newfoundland	?	Denmark	50	Wild-trapped	?	
	1949–50	Outer Island, Wisconsin	Wisconsin Conservation Commission	Norway, Finland	5	Mostly wild-trapped	Good to poor	A few seen the first year after liberation, then disappeared.
Hazel Grouse	1905	Grand Island, Michigan	Cleveland Cliffs, Iron County	?	12	Wild-trapped	?	Two reported next year.
	1906	Grand Island, Michigan	Cleveland Cliffs, Iron County	?	19	Wild-trapped	?	Disappeared.
Willow Ptarmigan	1905–06	Grand Island, Michigan	Cleveland Cliffs, Iron County	Norway	35	Wild-trapped	?	Disappeared.

factors are in productive conjugation.

Neither the original references nor Table 1 provides many clues to explain the failure of the releases. Many of the birds were wild-trapped in Scandinavia, where, as will be seen, the climate, habitat, and food available are similar to conditions on many of the areas of liberation.

The number of birds introduced was in most cases small; but successful plantings of pheasants (*Phasianus colchicus*) and Hungarian partridges (*Perdix perdix*) (Phillips 1928:34–36, 42–44), and chukars (*Alectoris graeca*) (Christensen 1954) have been made with relatively few birds.

The outstanding record of introduction is of capercaillie into Scotland, from which country they had been exterminated between 1745 and 1760. They were successfully reintroduced in 1837–38 from a stock of 49 birds, wild-trapped in Sweden (Harvie-Brown 1879). The success of this

venture might be contrasted with the less successful attempts to introduce sharp-tailed grouse (*Pedioecetes phasianellus*) into Michigan between 1938 and 1952 (Ammann 1957:25–32).

Of 23 releases totaling 1,491 birds, 4 were successful, 3 were partially or probably successful, 15 were failures, and 1 was uncertain. Of those that were successful, one release of 29 individuals and one of 37 were made on islands, which would limit a normal tendency for introduced birds to wander widely (Christensen 1954, Ammann 1957:32). The other three successful releases were of 49, 51, and 107 individuals respectively. The number of individuals in the plantings that failed varied from 30 to 148. In Scotland, only 4 of the 12 introductions of capercaillie exceeded 23 birds; of the 10 black grouse trials, only 4 consisted of more than 18 individuals.

In other species, larger numbers of individuals or repeated trials have resulted in establishment after the unexplained failure of the first attempt. The adaptable house sparrow (*Passer domesticus*) was planted three times in Quebec city before it gained permanent hold (Phillips 1928:58). Several early attempts to transplant the aggressive starling (*Sturnus vulgaris*) were unsuccessful (Phillips 1928:54; Kalmbach and Gabrielson 1921:4). Early plantings of pheasants, beginning in 1733 and sometimes repeated, were made in many parts of the eastern United States (Phillips 1928:42-43, Studholme and Benson 1956:389-392); in Oregon in 1881 (Einarsen 1945:254); in California about 1889 (Hjersman 1947:3); before or close to the turn of the present century in Ohio (Hicks 1938:3), Michigan (McCabe et al. 1956:265), Wisconsin (Schorger 1947), and the Lake States (McCabe et al. 1956:268). These plantings often numbered 50-100 birds, or even more; still, a surprisingly large number failed, sometimes in areas in which the same species later became abundant.

Table 1 provides too few records of the physical condition of the grouse at the time of release to evaluate the effect of this factor on survival. General health, alertness, ability to fly well on release, and freedom from debilitating diseases and parasites, all conditions to which little attention has been paid, must be considered in evaluating the causes of failure.

Although little proof is available, it seems likely that a species exhibiting a cyclic type of abundance may fail to survive in a new environment because of the date of trial. All four species of grouse introduced into North America exhibit well-marked cyclic fluctuations in abundance (Mackenzie 1953:128-138, Siivonen 1948:14-24). Since our woodland grouse are

also cyclic (Leopold 1931:134-148; Clarke 1936:62-79; Bump et al. 1947:578-579), the records of population peaks and valleys for both groups were examined in relation to the dates on which capercaillie and black grouse were introduced.

Published records of Scandinavian grouse cycles for the period covered by the American introductions are not common; those for Great Britain are detailed by Mackenzie (1953). Early records for Finland are given by Airaksinen (1946) and later ones by Siivonen (1948); Westerskov (1943) provides some Danish records. I secured some Norwegian records from local game biologists during my study of grouse in Scandinavia in 1949-50 (Bump, G. 1950. Report on black grouse and capercaillie. Unpublished ms in files of U. S. Fish and Wildl. Serv. 94pp.). A comparison of Scandinavian records with those for Britain indicates a general though inexact synchrony of capercaillie and black grouse abundance over many years. Hence the much more complete British records were also considered in determining the cyclic status of Scandinavian grouse during the dates of American trials.

In Table 2 are given the records, based on the sources referred to above, of high and low population figures for capercaillie and black grouse in Britain and Scandinavia for most of the period during which these birds were being introduced in North America. Sweden is not included in the table because I found scarcely any Swedish records for this period.

Comparing the data in Table 2 with the dates of introduction, and assuming that the birds were caught or raised in the year in which they were shipped, I think the evidence suggests that capercaillie were close to the peak of their cycle in two of the years in which American trials were made, on the upswing in two more, and

Table 2. Years of high and low populations of capercaillie and black grouse in northern Europe between 1880 and 1910.

GREAT BRITAIN				NORWAY		FINLAND	
Capercaillie		Black Grouse		Black Grouse		Black Grouse	
High	Low	High	Low	High	Low	High	Low
		1880	1882-84				
1887		1887					
		1891	1892	1891			
1896-97		1896	1897		1896	1896	
1902		1902	1903		1900		1900
1905		1905-06	1907	1906		1906	1908
1910		1910					

near the bottom in six. Comparative data on the remaining two dates are not available. Of the 10 black grouse introductions listed, 7 were made while this species was probably near its peak of abundance and 1 on the upswing of the cycle. The data on two records are insufficient to justify comment.

If, as has been suggested but not proven, introductions of cyclic species made during the upswing or near the peak of their cycle are more likely to succeed than those made during the decline or low period, then most of the capercaillie trials were carried out in years not conducive to success. The reverse is true for the black grouse releases, however.

No one knows whether the survival of a cyclic species released in a new environment is affected by the presence of closely related native species at a different point in their cycle. Still, the possibility exists that the upswing or peak phases of a cycle are more favorable for liberation than the declining or low phases. Ammann (1957: 34), referring to the Michigan sharptail releases, found that "all of the successful or partially successful releases were made in the rising phase of the grouse cycle." A few of the releases that failed were also made during this period, but most of them were made when the species was already in its declining phase.

Data on the cyclic fluctuations of ruffed grouse (*Bonasa umbellus*) in the general area in which many of the releases of capercaillie and black grouse were made are substantial (Leopold 1931, Clarke 1936, Bump et al. 1947:555-577, Ammann 1949). A comparison of these data with dates and areas in which the capercaillie and black grouse were liberated shows four liberations of capercaillie during periods of high ruffed grouse abundance, four during the rising phase of the ruffed grouse cycle, and one during its decline. Comparative data on three liberations are not available. Four of the black grouse releases were made close to the peak of the grouse cycle, two during the middle of its upswing, and one when grouse numbers were declining. Three records are not correlatable. If the chances of success are enhanced by making introductions when closely related native populations are up in their cycle, then 8 of 12 capercaillie and 6 of 10 black grouse liberations were made when this factor was favorable.

EVALUATION OF CAPERCAILLIE AND BLACK GROUSE

It is not within the scope of this paper to present a detailed evaluation of the four species of grouse tried to date. The willow ptarmigan already occupies suitable habitat in Alaska and Canada, and the hazel

grouse is so close to our ruffed grouse in characteristics and habitats as to make further trials unwise (Pynnönen 1954). The substantial and continuing interest in capercaillie (Fig. 1) and black grouse warrants a more detailed analysis of some factors that have a bearing on the results of the trial introductions here reported.

Capercaillie and black grouse have many characteristics in common. Both are cyclic, are nonmigratory but wander widely, often gather in flocks or sex packs of considerable size seasonally, are budders in winter, and share many food and cover preferences. Each is a forest-dwelling species capable of withstanding severe winter conditions and considerable snow. Both are very highly regarded by the hunting fraternity of Europe and Asia.

Potential Adaptability

Capercaillie and black grouse are widely distributed throughout Europe and Asia. Speciation has been substantial: 2 species and 15 subspecies of capercaillie and 2 species and 7 subspecies of black grouse are recognized (Peters 1934:24-28). Most of these have adapted themselves to a wide variety of forest habitats in Europe and Asia; the reintroduction of capercaillie into Scotland has already been mentioned. But not one species has been successfully acclimatized in North American forests in spite of repeated attempts.

Habitats

Capercaillie and black grouse do not have the same habitats, though there may be considerable overlap and they may even occur in the same coverts (Mackenzie 1953:140-141).

Capercaillie.—Lloyd (1867), referring to Norway and Sweden, described capercaillie habitat as "mountainous and hilly districts where pine woods abound, particularly such as are of mature growth and

studded with lakes and morasses. Sometimes, however, it is met with in woods interspersed with deciduous trees, more especially the oak, as it feeds freely on acorns. Excepting in the autumn, and when the young are small and follow their mother, these birds are seldom seen in brushwood or even in woods of young growth, and then only when in the vicinity of great woods."

Harvie-Brown (1879) indicated that "The beau-ideal . . . would appear to be a forest of spruce, Scots fir and larch, mixed, . . . of which a fourth or fifth consists of old timber and the remainder of a succession of growths in regular rotation." Pennie (1950:72) listed preferred habitat in Scotland as "old open pinewoods on the hillsides with an undergrowth of heather and blaeberreries," and mentioned that, with the destruction of mature pine woods, there has been a definite tendency to colonize pine plantations of 20 years or older (pp. 69, 71).

Again referring to capercaillie in Scotland, Mackenzie (1953:140) indicated that it is "found mainly in mature coniferous woods especially in winter, but since many of these were felled during the two wars, I have found woods from 20 to 30 years old being colonized, and the bird occurs in 10-year old plantations of my own. I have also found it on the open moor feeding on blaeberreries, and commonly in hardwoods with scrubby undergrowth, especially near pinewoods."

In the southern Urals of the U.S.S.R., Kirikov (1937) reported a race of capercaillie (*T. u. uralensis*) (Dementev et al. 1952) that spend the winter months in forests of pine (*Pinus* spp.) and larch (*Larix* spp.) and migrate some distance to oak-basswood-birch forests for the remainder of the year.

After a 6-month study of capercaillie and



Fig. 1. Captive male capercaillie photographed May 9, 1963, by Harry G. Lumsden (of the Ontario Department of Lands and Forests, Canada) at the Evo Research Station, Finnish Game Research Institute, Helsinki, Finland. The capercaillie is the largest species of grouse in the world; very large males from central Europe may weigh from 13 to 14 pounds.

black grouse in Europe, preparatory to the Wisconsin releases, I summed up my impressions of habitat in Scotland, Scandinavia, Austria, and the Italian Alps in an unpublished manuscript (1950) as follows:

The capercaillie is characteristically a bird of extensive coniferous or mixed hardwood-evergreen forests. Although second-growth woodlands and even young plantations are by no means ignored, the bird is most common in Scotland and Scandinavia in the rather open, uneven-aged or mature forests of Scotch pine and Norway spruce interspersed with birch, aspen, mountain ash, alder, willow, and juniper. Its central and southern European coverts are usually more varied, with

beech, oak, maple, basswood, and ash as common components, although always in mixture with evergreens, usually pine and spruce.

Other important habitat characteristics may be noted. Because of the birds' wide winter cruising range, areas reforested solely with pine or with pine and spruce or larch, although occasionally several thousand acres in extent, still may support goodly numbers of birds.¹

In Scandinavia, capers are also found

¹ I once flushed 15 capers in Scotland from a 70-year-old pure pine plantation about 150 acres in extent. Another pine, spruce, and larch plantation about 50 years old and covering about 700 acres was said to have supported up to 150 birds in years of peak populations.

well scattered through forests extending for miles in every direction providing there are swamps, bogs, rock outcroppings, lakes, steep hillsides, or other natural features sufficient to encourage some interspersion of forest cover types. Birds seldom seem to tarry long in small patches of woods, but a cover mosaic consisting of forest with a scattering of farms and cut-over areas is often productive of high caper populations.

The density of the forest cover is also important. Many fine caper habitats are but moderately dense or indeed almost parklike, resembling in appearance our not-too-heavily grazed or mature northeastern woodlands. Seldom were birds found to be common in densely forested areas. This is not surprising when one considers that the wingspread of an adult capercaillie is almost 5 feet. Thick patches of undergrowth over 3–5 feet high also seem to be avoided. Low undergrowth up to 2 feet seems, however, to offer no impediment to movement—in fact, low-growing species, such as juniper, blueberry, heather, cowberry, crowberry, bearberry, and bracken fern . . . seem to be almost as much a part of good caper habitat in Scotland and Scandinavia as is Scotch pine.

Black Grouse.—To a much greater extent than the capercaillie, the black grouse is a bird of mixed woodlands, birch, and aspen groves, brushlands, and even relatively treeless moors and steppes. Lloyd (1867) indicated that “Their chief resort, in Scandinavia at least, are [*sic*] pine woods interspersed with deciduous trees, more especially the birch. The deep recesses of the forest, which are the favorite haunts of the capercaillie, this bird would seem to shun, keeping, on the contrary more to the confines of the woods and to the borders of the numerous and extensive morasses with which the northern wilderness is studded. During the summer and autumnal months, however, one meets with

them in open moorlands, where, indeed, many breed.”

The Handbook of British Birds (Witherbee et al. 1941:216) described black grouse cover as “fringes of moorland . . . rough, heather-grown or bushy land, sparsely wooded places and bushy borders of woods or plantations, rushy pastures and marshy ground . . . frequently . . . with scattered birches . . .”

While I was traveling in Denmark with Kaj Westerskov, former Danish game biologist, he identified a vast sandy heath, almost devoid of trees but thickly covered with blueberries, heather, crowberry, and cowberry, as typical year-round black grouse cover.

In the Austrian and Italian Alps, after the last war, I found this species occupying the berry-laden moors at or above treeline in summer and early fall, and the rather open mixed conifers and hardwoods (at a much lower elevation) during the colder part of the year.

Professor G. Notini of Sweden, an authority on wildlife in Sweden and long in contact with Russian game biologists, indicated to me (Personal communication) that there exists in southern Russia, in the northern part of the Kirghiz steppes and in the vicinity of the northern Caucasus Mountains, a race of black grouse that prefers steppe lands and cultivated fields to an extent reminiscent of the ring-necked pheasant. But over most of Norway, Sweden, and Finland, where black grouse are particularly abundant, I found them in and along the edges of the fairly open forests of pine, spruce, birch, aspen, willow, and juniper, and in the adjacent barrens.

Foods

The food habits of the black grouse, and of the capercaillie except in winter, are

similar to those of our native woodland grouse. Throughout much of the year they are budders and browsers, with a shift to seeds and berries in summer and fall. Insects are taken occasionally, principally by chicks under a month old (Rajala 1959). Helminen and Veramo (1962:2-3) found 10.7 percent of the crops of 651 capercaillie and 831 black grouse taken in Finland to contain animal matter in autumn. The amount of animal food per crop was very small. No significant difference between the species in amount taken was observed.

Little damage to agricultural crops by capercaillie or black grouse has been reported. Cultivated grains, especially oats, are attractive to black grouse in the fall and winter (Seiskari 1954); capercaillie occasionally feed on corn (Pennie 1950:73). A more serious, though still small, problem is the capercaillie's predilection for pine needles and buds. The situation is summarized in *Nature* (Anonymous 1956) as follows:

In winter, the capercaillie's food includes the shoots, buds, leaves, seeds and young cones of the Scots pine, and occasionally those of other conifers. These, however, form only a small proportion of its total food supply, and where only relatively small numbers of capercaillies are found amid middle-aged or maturing pine woods, little serious economic damage results. The position may be very different in young, newly established plantations, particularly where they lie close to older woods with a heavy stocking of capercaillies. These birds find the winter buds and growing shoots of the young pines very palatable, and all too often they peck out the leading bud, thus causing serious loss of annual growth and perhaps a distorted stem.

Scotch pine (*Pinus sylvestris*), possibly because of its wide distribution throughout northern and central Europe and Asia, is preferred, but Kirikov (1937) mentions that

two Siberian pines (*P. cembra sibirica* and *P. c. cembra*) are also eaten and that larch (*L. sibirica*) is a common fall food. Captive capercaillie, in the Wisconsin experiment, accepted without difficulty white pine (*P. strobus*) and jack pine (*P. Banksiana*) as food. Spruce (*Picea* spp.) is not much eaten (Pennie 1950:72).

Reliable food-habits studies on capercaillie, black grouse, or both have been reported by Pennie (1950) for Scotland, Rajala (1959) and Helminen and Viramo (1962) for Finland, Westerskov (1943) for Denmark, and Kirikov (1937) for the Russian Urals. Lloyd (1867) is an earlier reference for Norway and Sweden. The essential points in all these reports are that (1) pine and capercaillie are constant, if not necessary, winter companions, and (2) birch and black grouse are the same; in fact, the black grouse is called the "birk-huhn" or birch chicken throughout central Europe. Of 40 genera of plants eaten by these grouse in Europe and Asia, nearly all are found in the United States.

Climatic Considerations

In addition to food and habitat requirements, the climate characteristic of the range of a species is important in evaluating its potential adaptability to new environments. As might be expected with wide-ranging species, both capercaillie and black grouse are found under a considerable variety of climatic conditions.

In general, both species occupy habitats where summer temperatures are moderate, seldom rising above 80-90 F, and winters are cold to frigid, with minimum temperatures falling to -40 F in parts of Siberia. Average annual precipitation over most of the range varies from 20 to 60 inches a year, with snow the rule throughout the winter months; over much of the range, however, average monthly precipitation

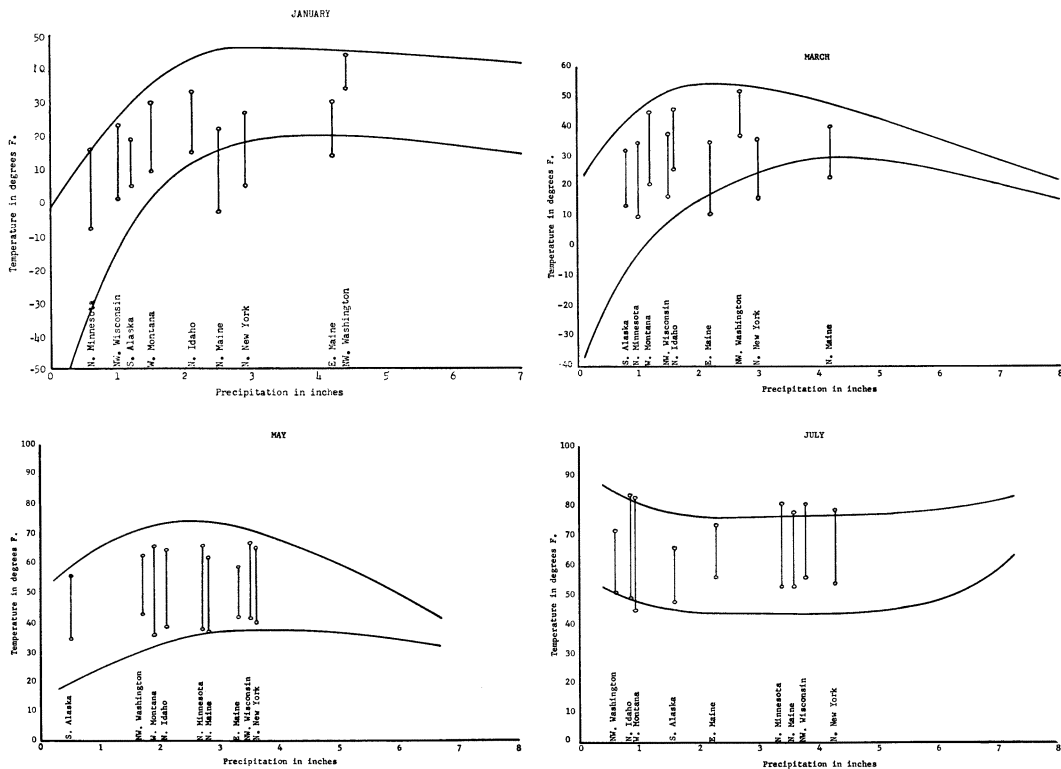


Fig. 2. Climacurvic comparison between native European and potential American habitats for capercaillie and black grouse—by months.

seldom exceeds 4 inches. Black grouse are found also where the rainfall exceeds 9 inches during some months, and capercaillie where it exceeds 5 inches. Of the two, the black grouse may be more adaptable to areas of heavy rainfall, for it is found in parts of southwestern Norway where precipitation reaches 80 inches a year. Millais (1892) reported that "in stormy, windy weather capercaillie are constantly on the wing seeking the thick cover of the lower elevations even though they have to travel considerable distances to reach such places." Conversely, he believed that black grouse are but little affected by wet weather.

Voous (1960:80) indicated that in Europe and Asia the limits of capercaillie

distribution "lie between the July isotherms of approximately 53°F in the north and of approximately 70°F in the south." In North America, the 53 F July isotherm extends across central Labrador, Hudson's Bay, and the Northwest Territories to northern Alaska. The 70 F isotherm passes through central New England and New York, extreme southern Ontario, Michigan, Wisconsin, lower Minnesota, and eastern Montana, dips southward along the Rockies to Colorado, and extends westward to eastern California, Oregon, and Washington (Reed 1941:667). The limits of black grouse distribution lie "between the July isotherm of approximately 51°F in the north and of 71°–75°F in the south" (Voous 1960:79). The northern isotherm

crosses North America slightly north of that indicated for capercaillie. The 75 F isotherm extends from southern New Jersey southward through western Virginia and North Carolina and eastern Tennessee, northward again through western West Virginia, thence westward through central Ohio, southern Iowa, and Wyoming, southward along the Rockies to New Mexico and Arizona, and northward along the mountains of the west coast to northern California.

For more information, one must construct climographs (Twomey 1936) or climacurves (Bump 1951:322), which illustrate the relation between rainfall and average maximum and average minimum temperatures. These have been drawn for the European range of capercaillie and black grouse, exclusive of the U.S.S.R. The average maximum and average minimum temperatures for 34 weather stations, each located within the range of these grouse and in or reasonably close to grouse-occupied habitat, were plotted by months in relation to the monthly precipitation indicated for each station. Lines representing the average maximum and minimum temperatures in relation to precipitation for the European habitat, were drawn by inspection. The average monthly maximum and minimum temperatures and precipitation for various parts of the United States were then determined (U.S.D.A. [N.D.]) and plotted on the same graphs. Graphs for all 12 months were prepared, and those for January, March, May, and July, often considered to be critical months for game birds, are reproduced here (Fig. 2). Even on casual inspection, they show a close correspondence between temperature and precipitation in the native habitat of capercaillie and black grouse and that in many of the areas in North America in which these birds have been released.

A review of the record makes it evident that there was considerable variation in the sites chosen for and the conditions attendant on the releases of capercaillie and black grouse here reported. The records of these liberations are not sufficiently complete to permit a factual determination of the causes of failure, but they do focus attention on many of the factors that may determine the success or failure of an introduced species.

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