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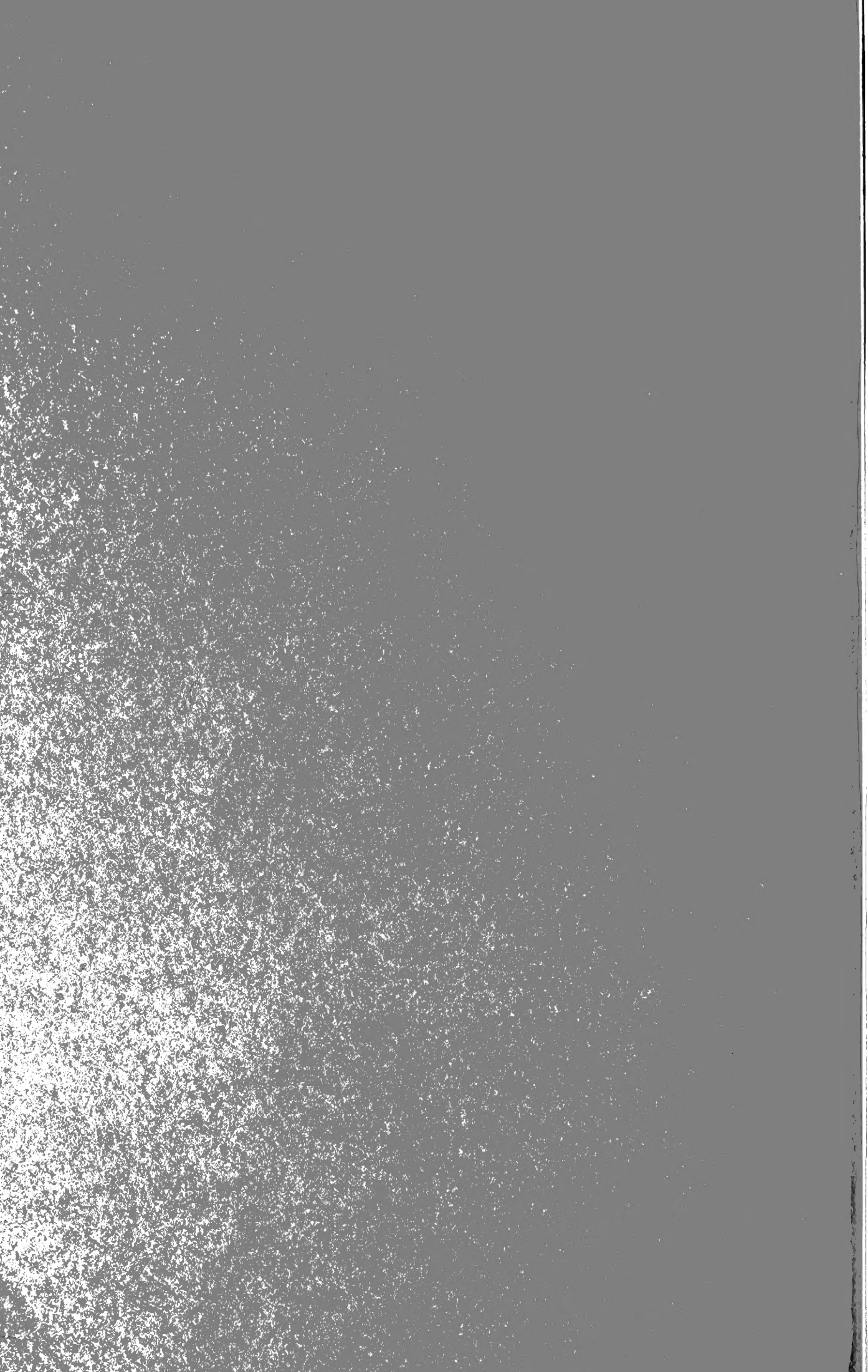
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**A DISCUSSION OF THE USE OF THE WORD "MIGRATION"
AS IT RELATES TO A PROPOSED CLASSIFICATION
FOR ANIMAL MOVEMENTS**

**By
F. A. Urquhart**

**100 Queen's Park
TORONTO, CANADA
May 22, 1958**



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DURING the past eight years the Royal Ontario Museum has been investigating the movements of the Monarch butterfly, *Danaus plexippus*, in North America. Having obtained a sufficient amount of data upon which to base an analysis and formulate probable conclusions, we were immediately faced with the difficulty of describing our findings in terms which would indicate a relationship, or similarity, to the movements of other animals. Unable to locate a well-defined classification, it was necessary to describe various terms which would be used in our published report and to indicate the relationship between such terms. The following discussion has been taken from the report so as to make it available to students, outside of the field of entomology, who are interested in the subject of migration.

The word "migration" has been used to denote many and varied movements of living organisms. We speak rather glibly of the "migration of birds," and the "migration of lemmings," when each represents an entirely different type of movement. The word "migration" as applied to birds does not define the type of movement; it merely denotes a movement in a broad sense. If we accept the meaning applied to the original Latin word *migro* (to pass from one place to another), then the word migration may rightly be used for the major descriptive word for all types of voluntary motion from one place to another. The word movement, which in many instances has been used as a scapegoat in order to avoid the use of the word migration, is derived from the mediaeval Latin *movimentum* and was rarely used in English between the fourteenth and eighteenth centuries; subsequently it was applied to a wide assortment of activities and hence is a rather poor choice as a descriptive word when applied to the type of activity with which we are here concerned—except when one wishes to be vague.

A word, whose meaning is not known, is but a sequence of letters or sounds. These assume meaning only when a well-defined pattern of thought, placed in descriptive terms, like so many bricks in a building, is applied to them. The meaning of a word may not be particularized; for example, the word "insect" conjures up in the mind of the person seeing or hearing it a vague mental image of the subject concerned; it does not transfer from one person to another a mental picture of a particular kind of insect. The words "beetle insect" transfer a much

more definite picture of a particular kind of insect. It is necessary, at times, to define terms as accurately as possible.

Before proposing an outline for a classification of the type of activity suggested in the word "migration," I should like to consider briefly the thoughts of a few of the many authors who have been concerned with this subject and to discuss briefly different types of movements.

Cahn (1925) defines migration as "A periodic passing from one place to another." He breaks this major classification into two subclasses, namely, (1) daily movements and (2) seasonal movements. The daily movements are feeding movements or reaction to light, and seasonal movements are related to breeding.

Thomson (1926) states:

To deserve the description 'migrating' in its strict sense, movements need not necessarily have a very great geographical amplitude, but at least they must involve a definite change of locality. They must be purposive in that the change of scene is associated with some definite advantage which serves as its *raison d'être* and there must be return movements to the original area. They must be periodic in that they correspond to some recurrent change either in the environmental conditions themselves or in the animal's reaction thereto. True migrations are changes of habitat, periodically recurring and alternating in direction, which tend to secure optimum environmental conditions at all times.

Williams (1930) takes exception to Thomson's definition:

To my mind this definition insists too much on the teleological aspect of migration, and it would be impossible to refrain from using the word migration to describe a change of habitat until the critical observer was convinced that optimum conditions had been reached thereby. Further, I am inclined to disagree with the requirement that "there must be return movement to the original area." In the first place this would prevent the use of the word migration for the well-known movements of lemmings and locusts . . . [Williams concludes] The definition of migration that appears to suit best the conditions as found in mammals, birds and insects is as follows: "migration is a periodic, more or less unidirectional, continued movement, assisted by the efforts of the animal, and in a direction over which it exerts a control, which results in the animal passing away from its previous daily field of operations." In cases where the animal is carried a long distance by agencies beyond its control the use of the term "involuntary migration" is not desirable and should be replaced by "involuntary distribution" or "dispersal."

Heape (1931) defines four types of movement common to many species of animals. When a population of a species of animal moves from one place to another without a return movement, this may be an *emigration* or an *immigration* depending on whether the animals are moving out of a particular locality (emigration) or into a particular locality (immigration). If a population moves from point A to point B, they emigrate from point A and immigrate into point B. If the population moves in random fashion from one locality to another, the move-

ment is termed nomadism. If a population moves from point A to point B and back again to point A, it is migration.

I agree with the definition of "migration" proposed by Williams, but I should like to expand it so as to include a change of location that is not necessarily periodic. But before presenting this wider definition of migration I should like to point out the various kinds of such activity that may be found for a particular species of animal, as for example, the barn swallow.

In late summer the barn swallow moves southward to its overwintering grounds and in the spring it moves northward to its breeding grounds. This is one type of movement to which the term "migration" has been applied. In the breeding grounds the swallow leaves the nest to obtain food for its young and returns to the nest again. This is quite a different movement and yet it is of a return type although vague in direction and encompassing a wide area. The term nomadism has been suggested for this type of haphazard movement. When the swallows prepare for their southward flight they gather together in flocks during the afternoon, remain so grouped together during the night, and disband the following morning in order to obtain food. This constitutes still another type of movement. Arriving in the overwintering quarters they disperse over a wide area, moving from place to place. This rather aimless movement is of a somewhat different type, though slightly so, from that found in the breeding area. There are, then, four types of movement. Should the word migration be applied to all of them? Is it possible to arrange a classification of movement that would allow an adequately descriptive term for each of them?

There are, of course, many other types of movements, such as the congregation of snakes in a particular area in preparation for hibernation; the movement of frogs to a pond in spring; and so on. Species of salmon on the west coast of North America return to the rivers and, having spawned, die. This is in part similar to the movements of birds, in that it constitutes a return trip, but it is a slightly different type of movement since it occurs but once and in each direction. Occasionally, for reasons that are not very clear, certain species of animals may suddenly appear in numbers, far beyond their normal geographical area, where conditions are not suitable for their survival. For example, the migratory locust, owing to factors involved in population density, will move in dense masses from one area to another. The sharp-tailed grouse of North America will move, under certain ill-defined conditions, far south of its normal range. The Norwegian lemming is a classic example of a mass exodus. These freak occurrences, which seem to follow an ill-defined cycle, constitute a quite different type of movement.

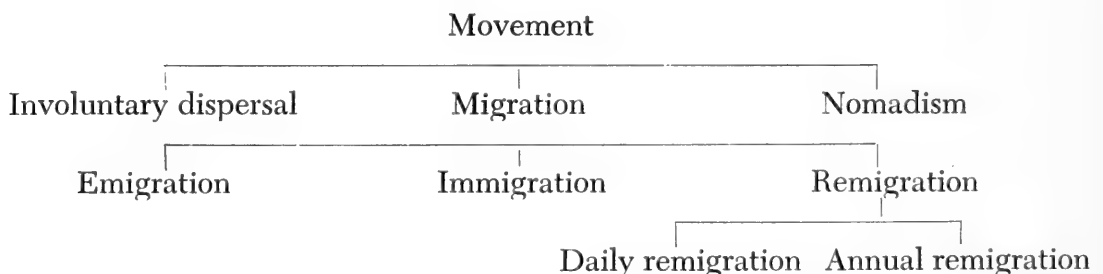
To sum up the above discussion we can arrive at one vague conclusion, namely that living organisms move from place to place for a

variety of reasons and as a result of a variety of stimuli. Let us, then, use the equally vague term *movement* for these activities. The word "movement" then, like the word insect, conveys a vague pattern of thought concerned with motion. No matter what the type of motion may be, we will term it a *movement*.

Movement, in turn, can be divided into three major categories, following the suggestion of Williams on the one hand and Heape on the other. An organism may be carried to a different locality by forces beyond the control of the organism, for example, a bird being carried by a strong wind, an insect being carried on a drifting log, or a butterfly carried across an ocean on a ship. Such involuntary movements I would term "*involuntary dispersal*" as suggested by Williams. An animal may move in a random fashion from place to place, as for example a herd of antelope grazing, a flock of starlings feeding, or ants foraging. Following the suggestion of Heape, I would apply the term *nomadism* to this type of motion. *An animal may move in one direction, as a more or less continuous movement, assisted by the efforts of the animal and in a direction over which it exerts a control which results in the animal passing away from its previous field of operation, as, for example, the flight of the swallow southward, the periodic movement of the Norwegian lemming and the migratory grasshopper. This kind of movement I would term a migration.*

As I have pointed out above, there are different types of migration. Williams emphasized this fact when he wrote: "This phenomenon [migration] occurs in the case of birds usually twice a year, i.e., once in each direction; in certain fishes twice a year, in others at intervals of several years, and in still others only twice in each lifetime; in some mammals, such as the lemming, once in several generations; in insects, sometimes twice in one lifetime, as in *Danaida plexippus*, but apparently more frequently once in one lifetime or only once in several generations." To this list might be added many more types of migration according to the definition given above.

The following broad classification is presented as a nucleus for a more exact system of smaller subdivisions:



Movement As I have pointed out, the word "movement" is of late mediaeval English origin and an adaptation of the mediaeval Latin word *movimentum*. When this word came into common usage, it had

a wide variety of meanings applied to it. In so far as it applies to living organisms its meaning may be given as *the action or process of moving*. Incidentally, the word *move* has been in common usage since mediaeval English and was an adaptation from the Anglo-French *mover* which in turn was derived from the old French *mouvoir* derived from the Latin *movere*. Hence, the noun "movement" was not derived from the verb "move".

Involuntary dispersal. The word "dispersal" was brought into use in 1821 and was derived from the French word *disperser* which was an adaptation of the Latin *dispersus*. Its meaning is "to scatter in all directions: to distribute from a source or centre." Either of these meanings will apply to living organisms. The adjective "involuntary" modifies the word dispersal to indicate that the act of moving is not controlled by the organism, and hence will distinguish a type of dispersal that is controlled by the organism resulting in range extension; the latter (range extension) is a subject of study with its own distinctive characteristics and limitations and is not properly involved in the present consideration of movement on the part of individuals or groups of individuals within a population.

Nomadism. This word was derived from *nomad* which is an adaptation of the Latin *nomas*, which in turn was an adaptation of the Greek *νομας*. It refers to the state of living a wandering life. As it applies to a living organism, it refers to *a random type of movement which is controlled by the organism*.

Migration. This word, dating back to 1611, was adapted from the Latin *migrationem* and means the action of migrating. The word *migrate* was formed on the Latin *migrat-*, *migrare*, and means to pass from one place to another. As the word migration applies to living organisms, the following definition, adapted from that of Williams, is proposed: *the movement of an organism in one direction, as a more or less continuous action, under the control of the organism, resulting in the organism passing away from its previous field of operation*.

Emigration. *E* is the shortened form of the Latin *ex* meaning *out of*. Therefore, the meaning of this word, as it applies to living organisms, may be given as: *the movement of an organism in one direction out of a given area, as a more or less continuous action, under the control of the organism resulting in the organism passing away from its previous field of operation with no return*.

Immigration. *Im* is the assimilated form of the Latin prefix "in" which is used in combination with verbs, or their derivatives, with the senses *into*, *in* and *within*. Therefore the meaning of this word, as it applies to living organisms, may be given as: *the movement of an organism in one direction into a given area, as a more or less continuous action, under the control of the organism, resulting in the organism passing away from its previous field of operation with no return*.

Remigration. *Re* is a prefix of Latin origin with the general sense of *back* or *again*. Therefore the meaning of this word, as it applies to living organisms, may be given as: *the periodic movement of an organism in one direction, as a more or less continuous action, under the control of the organism, resulting in the organism passing away from one field of operation to another with a return to the original field of operation.*

It will be noted that the definition which I have applied to the word *remigration* is the one which, in ornithology, is applied to the word *migration*. I am aware of the fact that the word *remigration* has been used in the sense "a movement of a portion of a species population from one locality to another with a return movement to the original locality by different individuals of the species." This is a most unfortunate use of the term because the prefix "re" has no significance in the definition as given. It is perhaps an attempt to change the original meaning of the word *migration* so as to preserve its significance in ornithology. That such an interpretation of the word can lead to difficulty is seen in the book *Principles of Animal Ecology* by Allee *et al.* On page 539 the above definition of *remigration*, as distinct from *migration*, is given, followed by the statement: "animals exhibiting migration in the strict sense of the word include the monarch butterfly, herring, salmon, eels, . . . and a great many kinds of birds." By the phrase "in the strict sense" the authors mean that migration is "a more or less continuous and direct movement, under the control of the animal, coordinated with or controlled by periodic environmental influences, from one locality to another, in which there is a periodic return to the original locality." No mention is made in this definition concerning return by the same individuals of the population, and yet *remigration* is made distinctive by involving a return by "different individuals of the species." Turning to the examples given above: until research was carried out by the Royal Ontario Museum, there were no data indicating that the individuals of the Monarch butterfly population that moved southward returned northward again. Data accumulated as a result of our studies indicate that some individuals return, augmented by first and second generations from individuals that did not return. Is the Monarch a migrant "in the strict sense?" Whether or not the eel is a migrant "in the strict sense" depends on whether you start with the adult eel in Europe and North America or with the newly hatched eel in the Sargasso Sea. In the first instance it is not a migrant, since the individuals do not return, and in the second instance it is because the young eels, on reaching maturity, do return. A similar situation applies to the salmon of the Pacific Coast of North America.

That the term *migration* has been loosely used is evidenced further by T. A. Coward who states: ". . . technically the word is applied to the passage or movement of birds, fishes, insects and a few mammals

between the localities inhabited at different periods of the year." He then enlarges the definition by stating that "a nomadic tribe of men is migration; the caterpillar migrates from branch to branch; . . ." Having thus expanded the definition, the author proceeds to limit it to a "periodic and regular movement." The difficulty, of course, is trying to fit too many kinds of movement into one ill-defined category.

Numerous other examples could be presented but they would add nothing more to the present discussion.

Use of Adjectives or Descriptive Phrases

As I have emphasized previously, there are many kinds of movement and many kinds of migration. How many there are and what their limitations might be can be decided upon only as the result of future studies. It would assist, rather than hinder, the studies of the movements of organisms if more kinds of movements could be named and described and fitted into an over-all system of classification. What I have proposed above may be compared to a phylogenetic system of classification for living organisms in which the phylum (movement) has been divided into three orders (involuntary dispersal, migration, nomadism), and one of these orders (migration) has been divided into three families (immigration, emigration, and remigration). Future studies will undoubtedly disclose the presence of more orders and these in turn will have associated with them an assemblage of families. It is conceivable that careful study of one family, such as emigration, might disclose a variety of distinct movements and hence the researcher might find it advisable to break this larger category into smaller units. Such a classification is necessary in order that we may not only classify our observations and experimentations but be able to refer to our results in terms of discrete categories. Referring to the word "movement" when dealing with the dynamics of an organism is as useless as referring to a species of insect as "phylum."

With the above conception of classification in mind I should suggest the use of descriptive adjectives and phrases to define more clearly a particular type of movement. For instance, on the island of Trinidad the Amazon parrot roosts at night among the trees in the Nariva Swamp on the east side of the island and feeds during the day in the northwest section of the island. As the sun is setting, chattering flocks of these parrots can be seen winging their way to the roosting site. This type of motion is a migration and, since it is a return movement it is a remigration; to define it still further the adjective daily might be used, since it takes place in one day, thus giving the further refinement in a definitive word combination of *daily remigration*. It would serve no purpose, at present, to coin new words and phrases for the many categories of movement found among various living organisms. Further studies, using a system such as I have proposed as a framework, will

lead to a larger but a more exact system. To indicate how the system might be applied in categorizing various types of movement, a few examples are now presented.

Example 1. A species of bird leaves its northern breeding grounds in the fall, overwinters in the more southern parts of the continent, and returns the following spring to the same area. This type of movement is a *migration*. Since it is a periodic movement carried out in one direction (north-south), as a more or less continuous action, under the control of the organism, resulting in the organism passing away from one field of operation to another with a return to the original field of operation it is a *remigration*. Since the remigration is closely related to the changing seasons it may be termed *seasonal remigration* or since it takes place every year it may be termed *annual remigration*.

Example 2. Individuals of a species of mammal suddenly move away from their normal range, and fail to return. Studies have shown that this peculiar type of movement occurs every seven to eleven years. According to our definition it is a type of *emigration*, or moving out of the normal range. Since it occurs at irregular intervals or periods, it might be given the phrase-term *periodic emigration*.

Example 3 (taken from *Principles of Animal Ecology*, by Allee *et al.*) A population of the ladybird beetle, *Ceratomegilla fuscilabris*, moves from the meadow grasses and forest leaves into the forest floor during the autumn, stays in the deeper portions of the floor mould during the winter, and moves into the meadow and upper forest strata the following spring, where it breeds and feeds upon aphids and other organisms. This is a type of movement but, as in the case of congregations of snakes in suitable locations for protection against the cold of winter, data on the direction of movement and possible topographic factors involved would have to be obtained before a descriptive term could be applied to it.

Example 4 (from same source as Example 3) Seven species of pulmonate snails move into the deeper water of Douglas Lake, Michigan, at the approach of cold weather, remain in deep water through the winter, and return to shallow water of the lake in the spring. This type of movement is, in so far as the data will allow categorizing, *seasonal remigration* or *annual remigration*. Whether or not all of the individuals involved return is, of course, questionable. There would, however, be no difficulty in changing from one category to another in the light of further information.

Example 5. The movement of the migrating grasshoppers of the Old World, the Norwegian lemming, and snowshoe rabbit would be categorized as *periodic emigration*.

Example 6. The adults of certain species of frogs and toads gather together in the early summer in local pools to mate and produce fertilized eggs. At the conclusion of the mating period, they leave the pools and spend the remainder of the summer moving from place to place in search of food (nomadism). The following spring they once again return to the pools. Although this movement is correlated with the seasons, to a certain extent, it is directed by a reproductive or physiological force. It is a *migration* and since it is repeated it is a *remigration*. Since it is correlated with the reproductive cycle it might be termed a *reproductive remigration* or since it takes place annually it may be termed *annual remigration*.

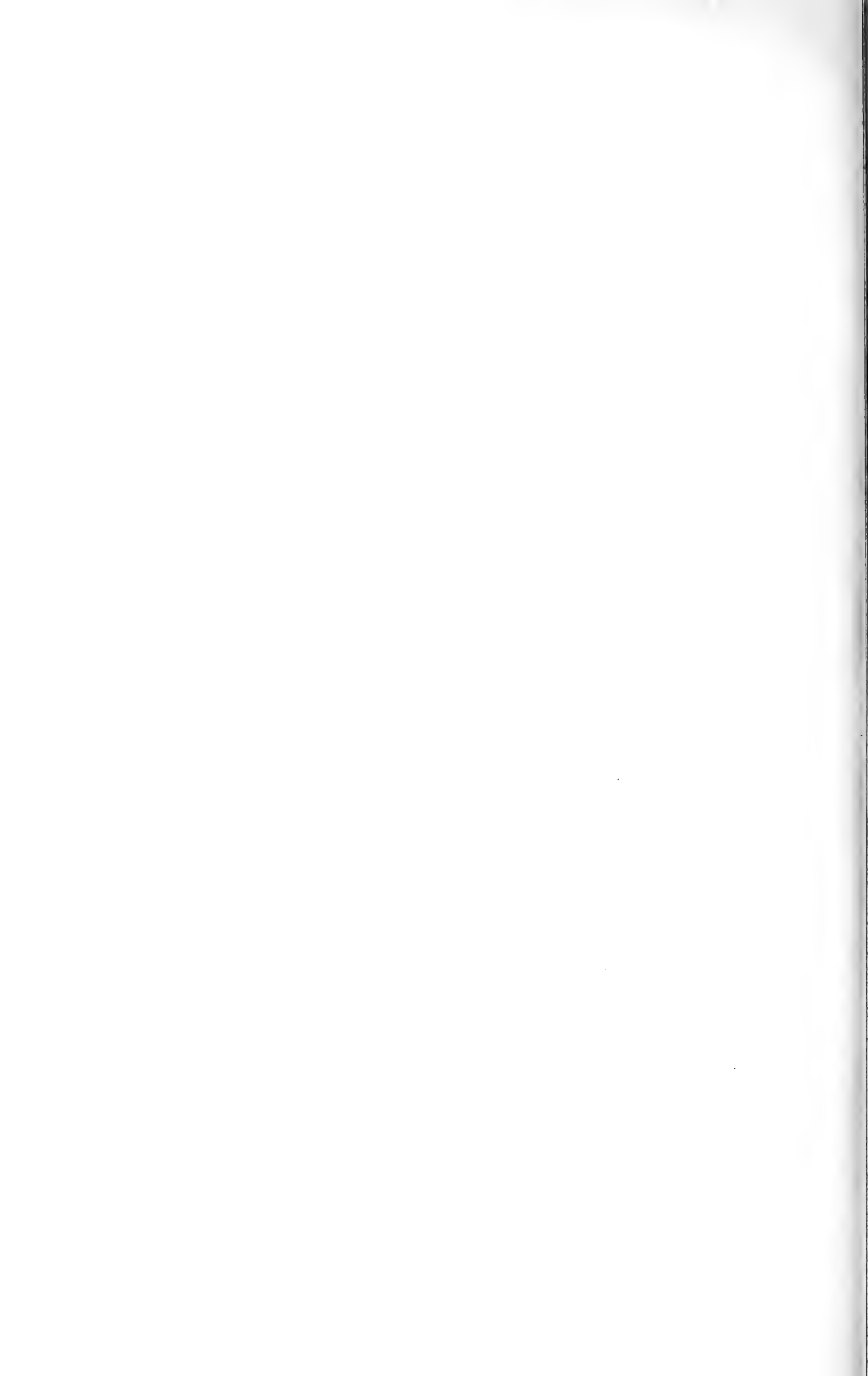
This particular case raises a rather interesting question with respect to the factors involved in bringing about a remigration. An anthropomorphic interpretation of the remigration in birds would be that the birds move southward in order to escape the cold of winter and, of course, the lack of food. It may be that remigration in birds is, in some manner, correlated with the retreat of the ice

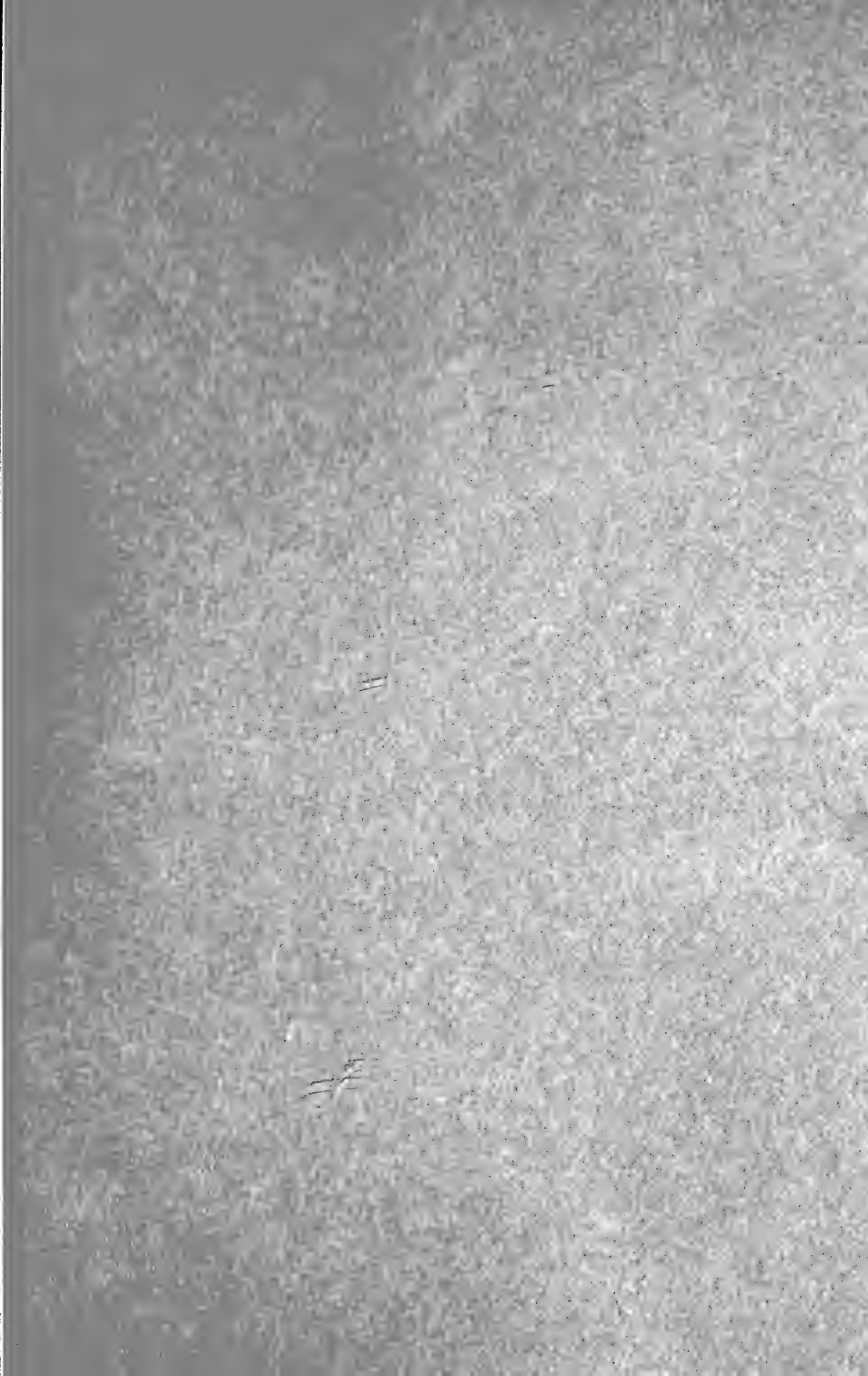
sheet of the last glacial period. The northward movement of birds is correlated with the development of the reproductive organs. Is this much different from what we broadly observe in various frogs and toads? Is it not a matter of distance that distinguishes the movements of one from the movements of the other? Since, however, the arrival at and departure from the pools is not in a given direction, as in the case of birds, and since the arrival at the pool is more obviously correlated with the reproductive cycle it may be more definite to refer to this movement as a *reproductive remigration*, although admitting its correlation with seasonal changes and its occurrence each year.

These few examples may suffice to indicate how a system of classification of the movements of animals may be used. In order that such a system may be made a useful one, it is important to avoid using the word migration as a definitive term and to avoid using a prefix, such as *re*, when the combination does not mean what the author intends. Migration is a perfectly good and usable term if it is used in its broadest sense, and it is a word which should not be limited, in scientific writings, to the movements of one particular group of animals, such as birds, and, conversely, the movements of one particular group of animals should not define the word. That an exact classification is desirable is most obvious when one consults the literature. An exact classification can evolve if an exact nucleus for it is established, accepted, and put into practice.

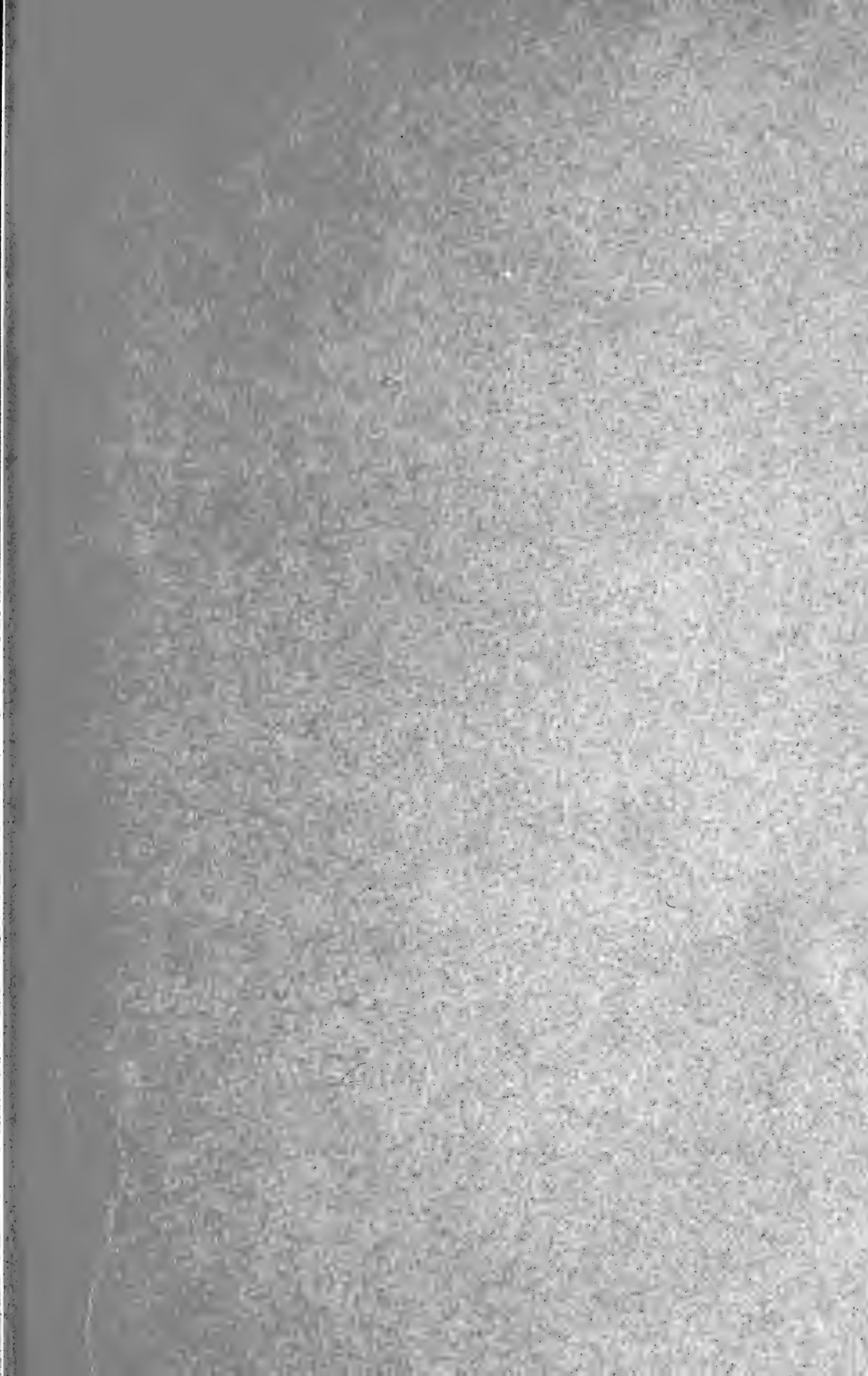
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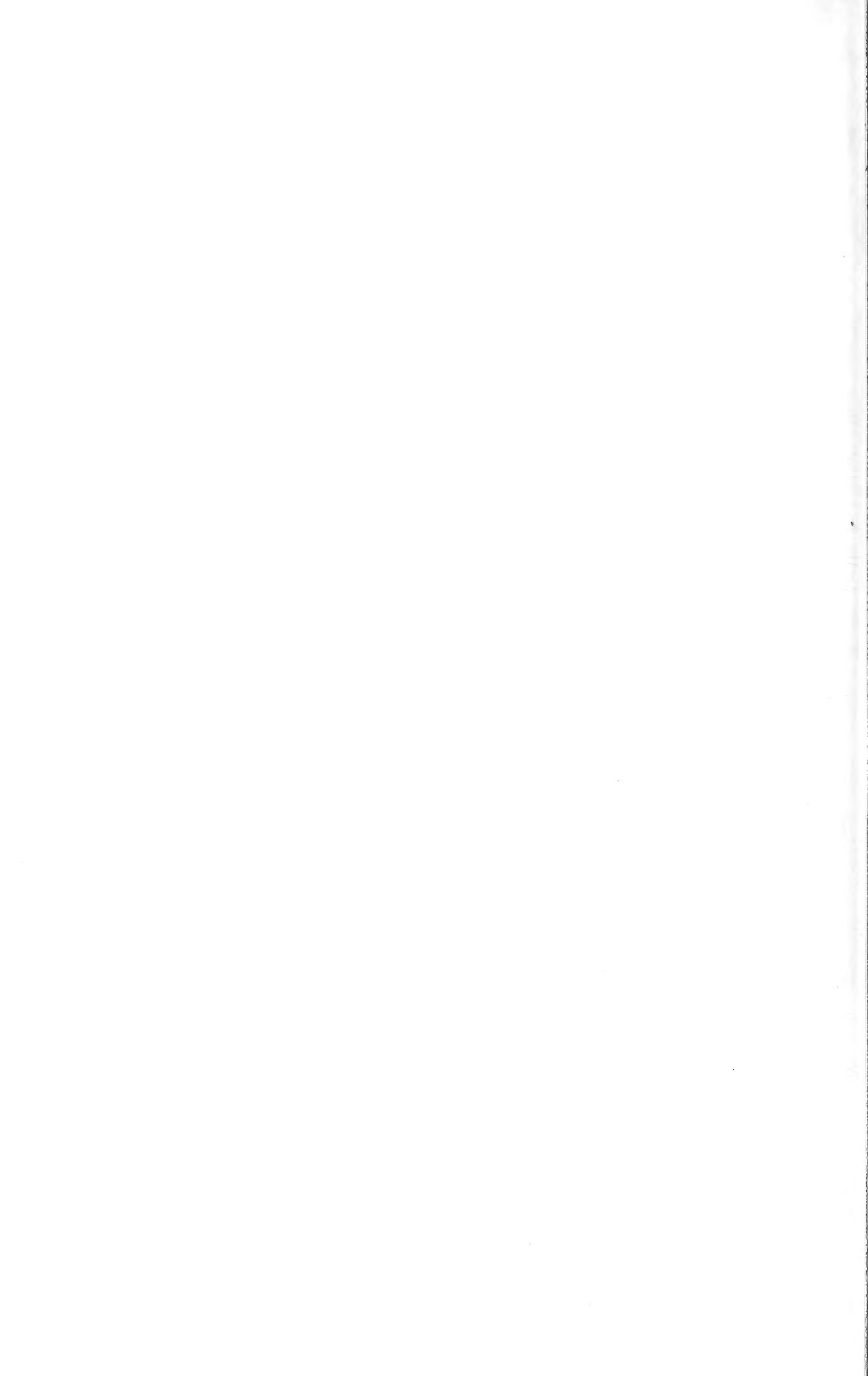












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