THE INCUBATION PATCH OF WILD GEESE: ITS RECOGNITION AND SIGNIFICANCE

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THE incubation patch of birds consists of one or more areas of the skin of the breast and belly that become denuded of feathers and highly vascularized prior to incubation. Its function is to permit intimate contact of the body of the bird with the eggs, thereby increasing the efficiency of heat transfer. In its formation down feathers alone or both down and contour feathers may be lost. In passerine birds this feather loss is caused by a localized molt that results from hormonal action. (Bailey 1952).

Whereas it is common knowledge that the incubation patch in waterfowl is formed when the female plucks breast fathers for the nest, little attention appears to have been given to the details of its formation and subsequent history. The present observations on the incubation patch of wild geese, which were made at Perry River, District of Mackenzie, N.W.T., Akimiski Island, N.W.T. (in James Bay), in the Sutton River area, Ontario (south of Hudson Bay), and at the Horseshoe Lake Wildlife Refuge, Alexander County, Illinois, have suggested that the patch, particularly in its subsequent refeathered state, which heretofore has not been generally recognized, may have significance and usefulness in population studies.

The following species and subspecies of geese have been studied (nomenclature after Delacour 1954): white-fronted goose *(Anser albifrons frontalis)*, blue-lesser snow goose *(Anser caerulescens caerulescens)*, Ross's goose *(Anser rossii)*, emperor goose *(Anser canagicus)*, Todd's Canada goose *(Branta canadensis interior)*, Moffitt's Canada goose *(Branta canadensis moffitti)*, lesser Canada goose *(Branta canadensis parvipes)*, cackling Canada goose *(Branta canadensis minima)*, and black brant *(Branta bernicla orientalis)*.

Acknowledgements

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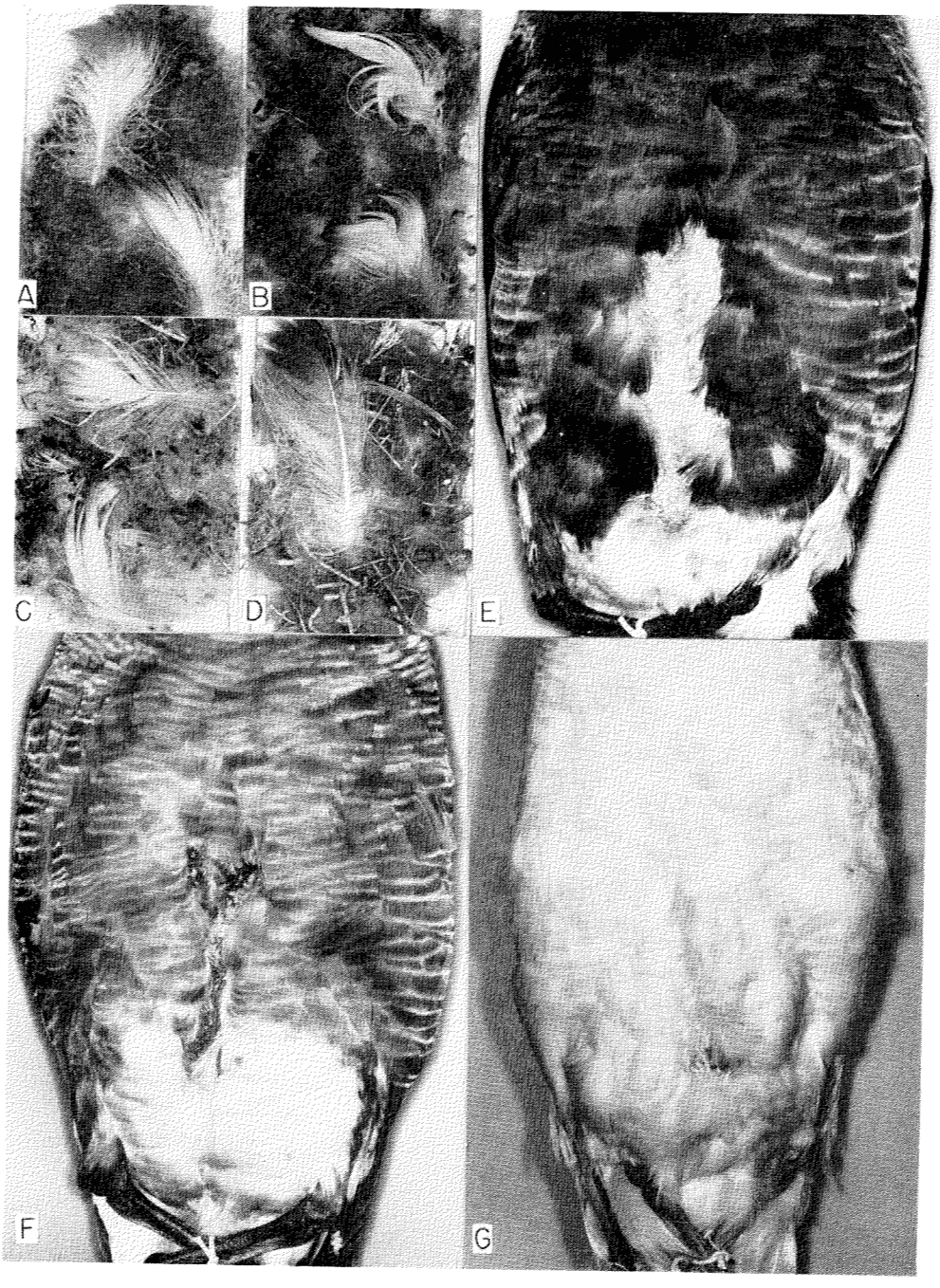

Fig. 1. A-D, Down and breast feathers from nests of: **(A)** black brant, **(B)** lesser Canada goose; **(C)** Ross's goose, **(D)** white-fronted goose. **E-G,** Undersides of adult female geese: **(E)** black brant at an early stage of incubation, **(F)** lesser Canada goose collected with newly hatched young, **(G)** Ross's goose collected with young 4 to 5 days old. All specimens from Perry River.

wild geese. For personal encouragement in this regard the writer is grateful to Admiral L. O. Colbert, Dr. Walter Wood, and Mr. Joseph Flakne of the Institute.

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The present paper is one of a series that will form the base of a definite report on the Canada goose. Progress toward attainment of this objective has greatly benefited by the constructive advice and support of Dr. Thomas G. Scott, Head of the Section of Wildlife Research.

Previous studies

Brandt (1943, p. 261) noted that during the breeding season Pacific eider ducks *(Somateria v-nigra)* possess two types of down; one, the *permanent* down, and a second, the *nuptial* down, the latter being coloured differently from the first and more readily pulled out. It is clear from the writings of Brandt (1943, p. 261) and Witherby *et al.* (1943) and supported by the writer's experience that geese pluck and use both down and contour feathers in the nest (Figs. 1A, B, C, and D). The amount of down in a nest of a duck is generally regarded as an indication as to whether the full complement of eggs has been laid, since the amount of down deposited increases with the progress of egg laying. Hochbaum (1944) has stated that in duck nests "down seldom appears in the nest before the third or fourth egg is laid; the nest may not be completely lined with down until it holds most of the clutch". Conversely, Brandt (1943) reported that geese do not deposit down in the nest in quantity as early in the incubation period as do ducks, and that important differences exist between species (see pp. 275, 325, 326, 330, and 333). The cackling Canada goose does not add much down to its nest, whereas the emperor goose deposits large amounts in the nest just before hatching of the eggs. Cottam *et al.* (1944, p. 51) state that "probably three times as much down is used [in the nest] by the brant as by the snow goose". Kossack (1950), reporting on semi-captive Canada geese near Barrington, Illinois (most individuals appear to have been *Branta canadensis moffitti),* wrote: "small quantities of down generally appear when the third egg is laid; the quantity of down generally increasing until incubation is started".

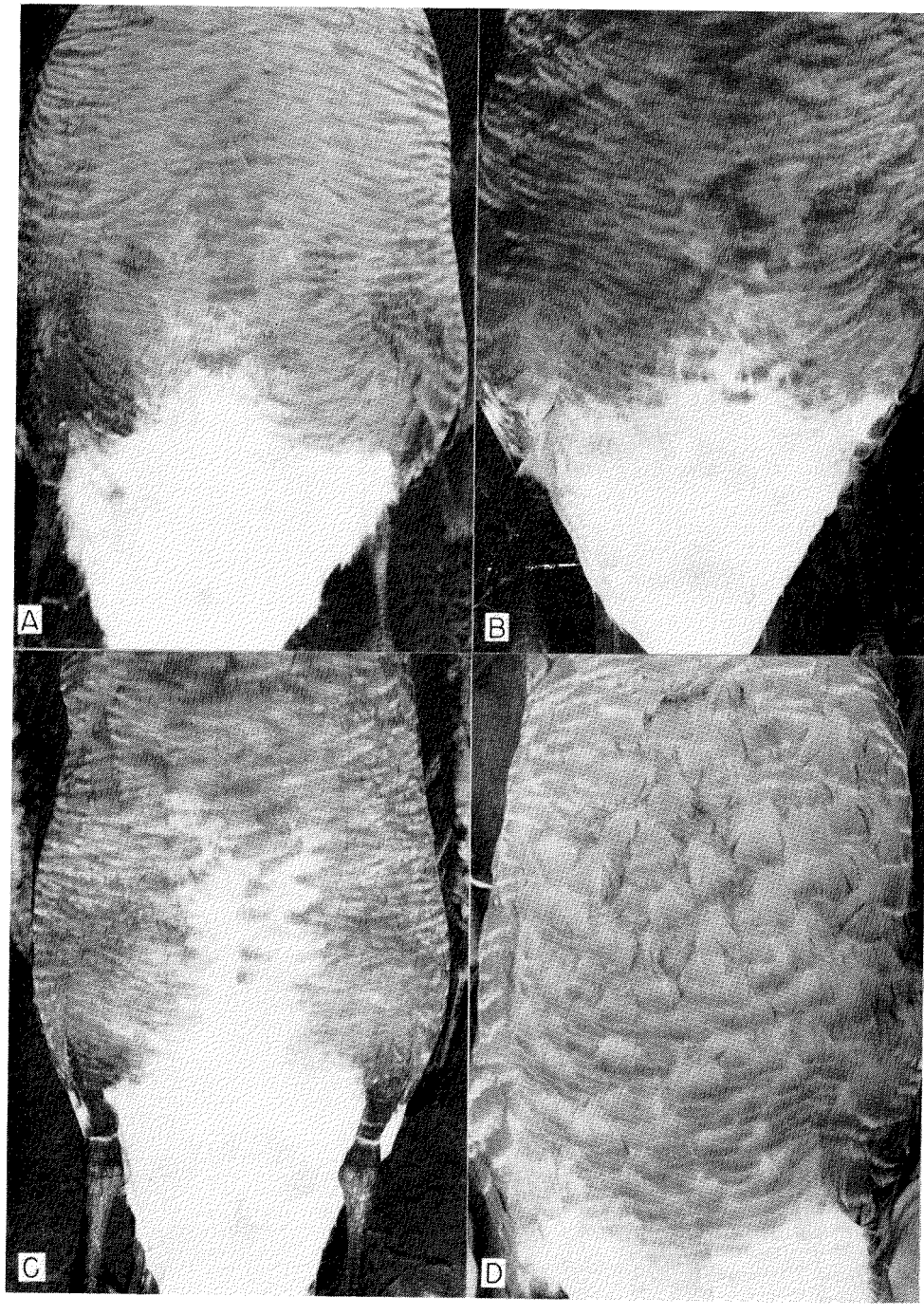

Fig. 2. A-C, Undersides of adult female Canada geese during the flightless period, **D.** the underside of an adult male during the body molt, Akimiski Island, N.W.T.

Phenology, characteristics, and occurrence of the incubation patch in breeding geese

The timing of the appearance of the incubation patch in geese and its refeathering can be roughly delineated by data from a variety of species and subspecies. The denuded area of the breast is most obvious during the incubation period. Two female black brant collected at Perry River during the early stages of incubation both possessed a large brood patch (Fig. 1E). Neither the sexually immature yearlings nor the adult males (which do not incubate the eggs) have an incubation patch.

As a female goose plucks her breast chiefly as the clutch nears completion and during the early stages of incubation, the denuded areas have begun to be refeathered by the time the young have hatched. The feathers of the incubation patch of a lesser Canada goose collected at Perry River with young only 1 or 2 days old had barely begun to grow (Fig. 1F); a Ross's goose collected at Perry River with a brood of five, estimated to be about 5 days of age, had its incubation patch partly refeathered (Fig. 1G). In Canada geese *(B. c. interior)* studied on Akimiski Island in 1958, all adult females had the patch area completely and evenly refeathered by the time their young were 2½ to 3 weeks old (Figs. 2A, B, and C). It was strikingly apparent, however, *that the area of feather replacement of these geese could be readily distinguished from the remainder of the breast because the newly replaced feathers were either more brightly coloured than the surrounding faded brownish breast feathers or were white or partly white.* In some only the edges of the new feathers of the incubation patch were white, thereby imparting a frosted appearance to the plumage. However, because the post-nuptial molt of the body feathers occurs shortly after the incubation patch has been refeathered incubation remains evident only if the new feathers are all or partly white.

During the spring migration at Hawley Lake (Ontario) in May 1959 the writer was able to distinguish readily three age classes of Canada geese: immatures (geese nearly 1 year old); yearlings (geese nearly 2 years old), and old adults (geese about 3 or more years old). However, during the flightless period on Akimiski Island in July and early August 1958, only two ages classes of geese could be distinguished: the immatures of the previous winter (classified as yearlings during their second summer of life) and all older geese.

Two-year-old females that have nested cannot be distinguished during their third summer of life from older females for the reason that the bursa of Fabricius is apparently absorbed rapidly during the early stages of incubation. The opening to the bursa of a 2-year-old female shot on June 3, 1959 was greatly reduced in size and its walls were membranous in character rather than glandular.

On the other hand, female geese during their second summer on the breeding grounds could be distinguished from older females by the possession of one or more pairs of badly abraded outer tail feathers, an open

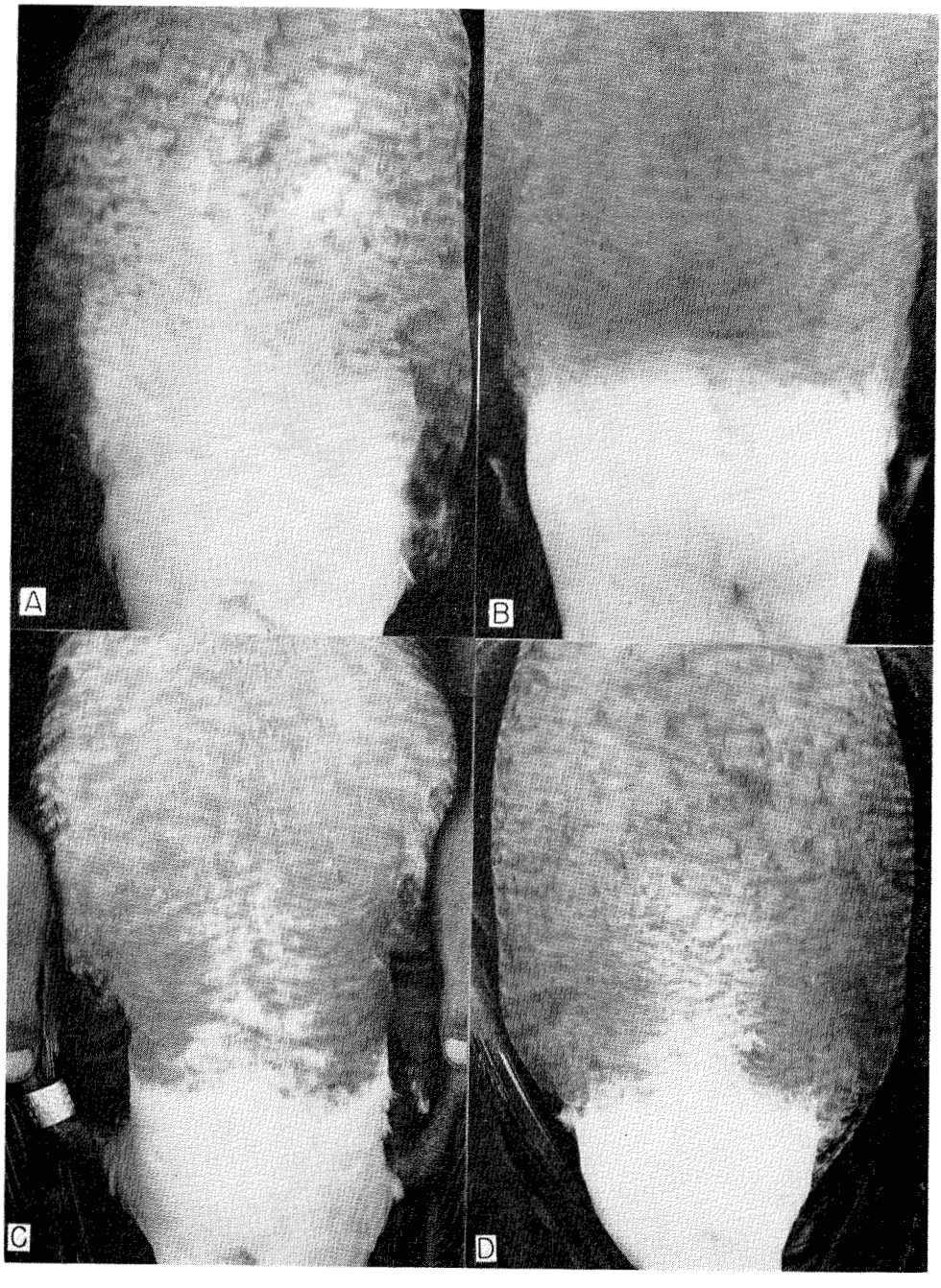

Fig. 3. Undersides of **(A)** an immature male, **(B)** yearling female, and **(C** and **D)** adult female Canada geese.

bursa of Fabricius or, even more positively, by a closed oviduct. The latter remains closed in yearling female geese throughout the second winter (Hanson 1949).

Evidence of a former incubation patch in wintering geese

The evidence in the form of different refeathering indicating a former incubation patch in Canada geese *(B. c. interior)* wintering at Horseshoe Lake, Illinois, was studied in late 1958. Immature geese are highly variable in the fall (Fig. 3A), frequently still undergoing the post-juvenal molt of their breast feathers, but this age class was readily identified by notched tail feathers, as well as by cloacal and other characteristics. Sexually immature yearling males and females, as well as adult males were eliminated from consideration by cloacal characters (Hanson 1949a). In these latter age-sex classes there is a fairly sharp line of demarcation, both in summer and winter, between the white feathers of the belly area and the grayish or brownish feathers of the breast (Fig. 3B).

Of 87 adult female geese studied that were 2½ or more years old and that had presumably nested the previous spring only 28 (32 per cent) possessed a feather patch on the underside that indicated a former incubation patch. In these individuals the patch feathers were either (1) all white (Figs. 3C and D), (2) some all white or with white tips and some normal (Figs. 4A and B), or (3) a mixture of light and dark (Figs. 4C, D, and E). These findings were in agreement with conclusions suggested by examination of birds on the breeding grounds: namely that in those individuals in which the colour of the new feathers of the patch area is the usual gray, the feathers of the former incubation patch cannot be distinguished from the rest of the feathers of the underparts after the latter have been replaced in late summer during the post-nuptial molt.

These observations give rise to questions that can at present not be fully answered. Are the feathers of the former incubation patch lost again at the time of the post-nuptial body moult? Skins collected in 1959 in late July, when the post-nuptial moult of the contour feathers was well under way, clearly provide evidence that they are not. The underparts of these skins show that replacement is taking place everywhere on the ventral surface of the body except on the patch area. It was notable that replacement was also taking place along the mid-line of the patch area, the strip over the keel of the breastbone that is not totally plucked when the patch area is denuded. The fact that patches marked by white feathers persist into the winter period and are not replaced by gray feathers during the post-nuptial moult is further evidence in this regard. Is the incubation patch of moulting geese a completely reliable criterion that the individual had nested in a given season? Experience gained by the writer with geese held in wire cages and from observations of non-breeding, sexually mature semi-captives would indicate that it is. No localized breast moult or differentially feathered area has been observed in these females although they

were handled during the spring and summer periods for several years in conjunction with physiological studies of the moult.

It probably can be assumed that females of most species of geese that have nested will show plumage evidence of a former incubation patch until some time during the flightless period, although in white geese or white-bellied geese (blue goose-snow goose crosses), some difficulty may be experienced in detecting the patch areas, although the amount of wear exhibited by the edges of the contour feathers should be indicative. To investigate whether geese other than Canada geese may show evidence of a former incubation patch in winter, skins at the Chicago Natural History Museum were examined. Species of North American geese that were represented by adult females contained in their series specimens that showed plumage differences associated with former incubation patches (Figs. 4F-J).

Discussion

The genesis of white feathers or partly white feathers in areas of former incubation patches of adult females, which in yearlings and adult males are normally gray or brown, is of particular interest. It was recorded earlier (Hanson 1949b) that white spotting in geese increases with age and occurs more frequently on the underside of the wings in old females. Physical injury to the follicle resulting from plucking would, at the outset, appear to be one possible explanation. For example, Hutt (1949, p. 182) stated that in domestic chickens "white feathers are occasionally found in birds that once had only black or coloured plumage. They may develop spontaneously, be caused by injury, or be induced by excessive doses of thyroxine."

Although an enlarged thyroid gland alone is not necessarily indicative of an increased rate of secretion, the fact that they tend to increase in size during the flightless period (Hanson 1958 and unpublished), is reason to suspect that thyroxine may play a role in the development of white spotting in the incubation patch.

Bailey (1952) has cited the report of an immature black-headed gull *(Larus ridibundus)* that developed incubation patches. However, the fact that the patch in waterfowl is dependent on plucking and that the hormonal level must be such that it induces this behaviour trait would seem to preclude the likelihood of a female developing an incubation patch without actually having laid eggs. In this regard it is to be noted that in waterfowl both the contour feathers and the down have the added important function of providing the eggs with insulation; in most passerine birds the lost feathers serve no further function. If the feathers of the patch area in waterfowl were molted promiscuously merely as a result of a higher hormonal level at the time of egg laying, they would not be available for placement in the nest. Instead, it would seem that there is a direct relationship between the plucking of the patch feathers subsequent to the initiation

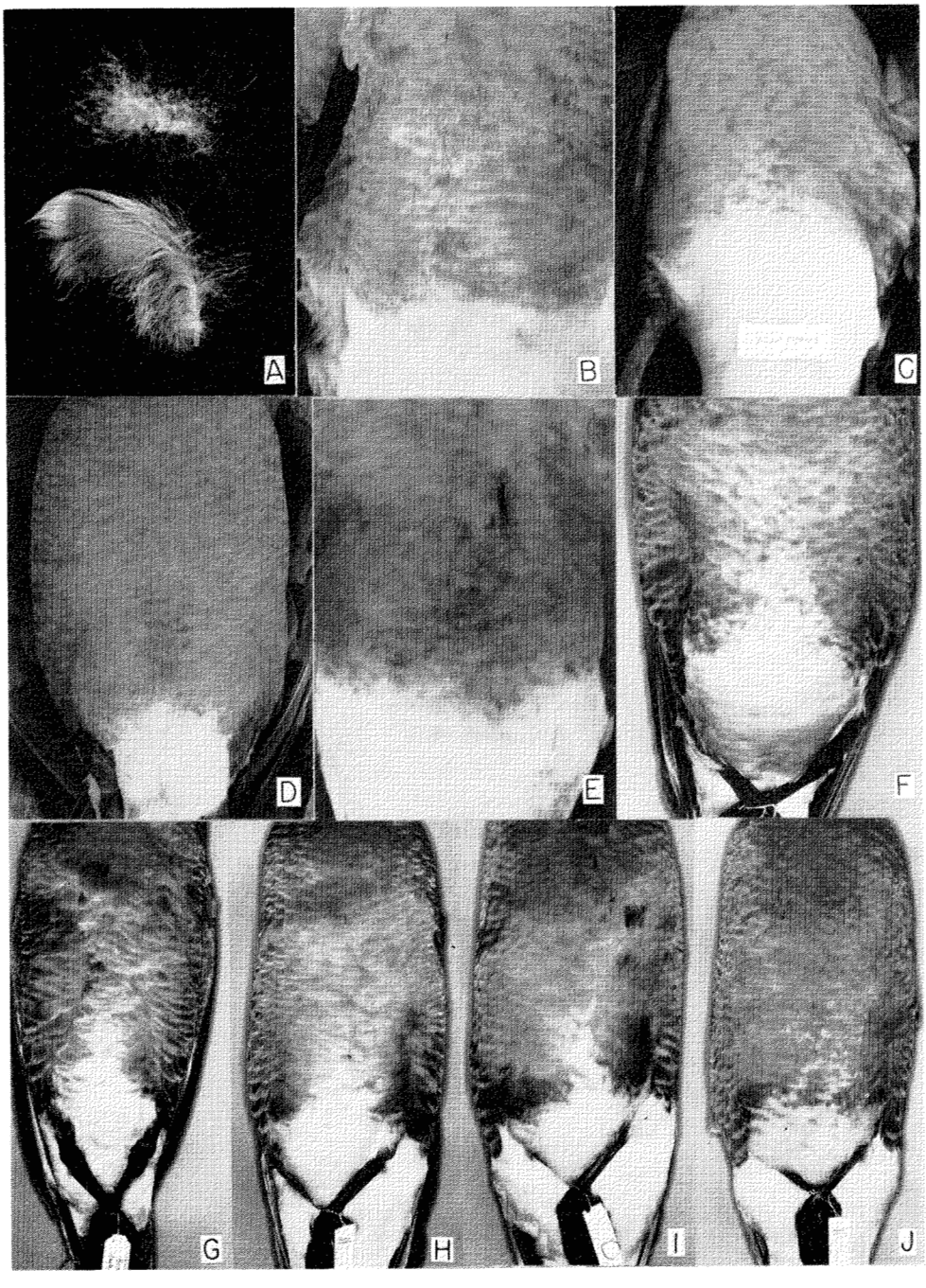

Fig. 4. (**A**) Breast and down feathers from an adult female Canada goose in late fall, (**B-E**) undersides of adult females from Horseshoe Lake, Illinois, (**F**) underside of a lesser Canada goose from British Columbia, (**G-J**) undersides of cackling geese collected in California.

of egg laying and the production of an incubation patch. In fact, a high dependence of the plucking behaviour on complete development of the sexual (hormonal) cycle is suggested by the fact that down is placed in the nest only in the later part of the egg laying period.

Evidence for this relationship was found in studies of nesting Canada geese along the Sutton River in the spring of 1959. A 2-year-old female nesting for the first time had a clutch of only three eggs and a small incubating patch; an old female that had laid a clutch of seven eggs (the largest found), had the most extensive incubation patch of eight nesting females collected (Figs. 5A and B respectively). It is presumed that prolactin is the hormone chiefly responsible for the development of feather plucking in geese nearing the end of an egg laying cycle.

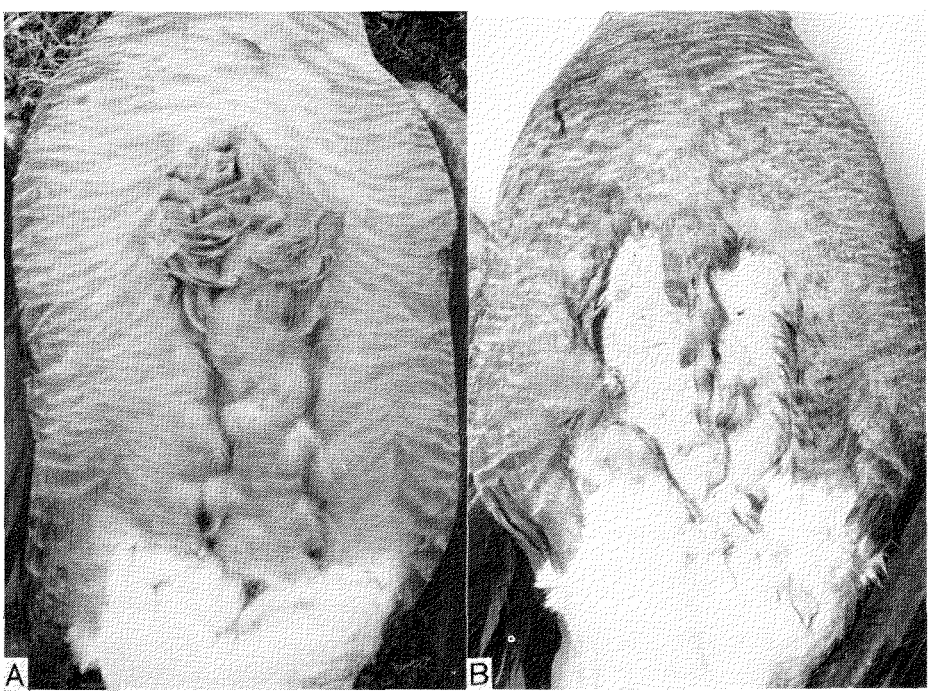

Fig. 5. Incubation patches of Canada geese during early stages of incubation. **(A)** a 2-year-old female on June 3, 1959 that had a clutch of three eggs, **(B)** an old female on May 28, 1959 that had a clutch of seven eggs.

Observations made to date on the incubation patch in geese suggest that it may have considerable use in population studies of these birds on the breeding grounds. From the findings at hand it is evident that in Canada geese (1) the incubation patch can be used throughout the flightless period as a convenient aid, in addition to cloacal characters, in distinguishing older females from yearling females and adult females from adult males, (2) that breeding in the wild often begins at 2 years of age instead

of 3, a possibility advanced earlier by Hanson and Smith (1950), because an apparently 2-year-old component of the population was not separable from older geese, either by cloacal or plumage criteria. Thus recognition of the refeathered former incubation patch during the flightless period should aid in productivity studies, as by its presence or absence the investigator is able to separate females that have laid eggs from those that have not.

Because only a relatively small percentage (32 per cent) of the adult females that may have nested during the breeding season could be recognized in winter (those with white spotted or mottled patch areas), successful diagnosis of recent breeding in females must lie in studies of molting females on the breeding grounds. In temperate regions it may be assumed that nearly 100 per cent of the sexually mature females lay eggs; in the High Arctic, on the other hand, the onset of break-up may be so late and the spring-summer period so cold that a significant part of the bird population of the region may not nest in some years (Marshall 1952). In such years the plumage characteristics of females caught in drive traps should be a fairly accurate measure of the extent of non-breeding that may have occurred. However, care would have to be taken in examining catches to distinguish adult geese from yearlings by cloacal characters (Hanson 1949a).

The proportion of geese with incubation patches plus age-sex ratios of the previous winter appear to have usefulness in making predictions of the size of the fall populations of Canada geese. During fall and winter six age-sex classes of geese can be distinguished: male and female immatures, yearlings, and adults. Separation of adult females that have nested from those that have not by means of the incubation patch now makes it possible to separate a seventh age-sex class in Canada goose populations. In summer, however, only five age-sex categories can usually be distinguished because most yearlings of the previous summer and winter are indistinguishable from older adults. In the past the size of fall populations of Canada geese of the Mississippi flyway has been successfully predicted a year in advance on the basis of age-sex ratios and assuming an average brood size of three for all adult females (Hanson and Smith 1949). A more refined appraisal of the kill of these geese by the Indians (Hanson and Currie 1957) has improved the accuracy of such forecasts (Donald Smith and Rossalius Hanson, U.S. Bureau of Sport Fisheries and Wildlife, personal communication). It is therefore possible that it also will be advantageous to ascertain what percentage of the adult females nested in a given year. Since it may not be feasible to do this every year because of the remoteness and difficult nature of the breeding grounds, a study over a period of several years would be desirable in order to obtain an average value. For threatened populations and those nesting in the High Arctic a study of the flightless females on the breeding grounds would be especially important.

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