THE FUNCTION OF THE OIL-GLAND[1]

WITH THREE ILLUSTRATIONS

By J. EUGENE LAW

It is with some trepidation that I re-open a discussion of the function of the oil-gland in birds. Of certain fundamentals, the evidence seems to be complete. The oil-gland is what its name implies, a gland of oil. I have seen the gland and I have seen an oil-like substance in the gland. I have applied pressure to the gland and I have observed the oil-like substance exuding at the tip of a more or less well defined nipple on the gland. On many species of birds I have seen the wee tuft of oily feathers which top this nipple. On the other hand, I have seen species of birds in which there is no trace of this oil-gland.

It is granted, then, that most birds possess an oil-gland which appears to be functional. What is its function?

Since time immemorial it has been assumed that this function is the lubrication or anointing of the feathers, usually with the added thought that it keeps the plumage from becoming water-soaked. Around this assumption has developed a body of logical and illogical legend which has been and is today accepted as part of the gospel of ornithology.

Previous Discussion. In 1832, Charles Waterton called the attention of ornithologists to the impracticability of the prevailing theory that the function of the oil-gland was to lubricate the feathers. At once a controversial discussion began in the pages of the Magazine of Natural History, and later extended to the pages of The Zoologist. Smothered under forensic fireworks, the dispute ended in a draw with neither side yielding. Repercussion at intervals in the succeeding years has made no apparent inroads on the mass thought. The oil from the oil-gland continues to lubricate the feathers, as of old.

Or did, until yesterday. Today, I am compelled to believe that Mr. Waterton was right, that the function of the oil-gland is not to lubricate the feathers. And to the reasons he presented for disbelieving this pretty theory that feathers are anointed with oil, reasons just as cogent today and as solid as when he presented them nearly a century ago, I propose to add other reasons for discarding this age-old belief, and to present a new theory which, while perhaps hardly easier to establish as fact, yet seems better to fit observed fact.

In taking the position that the feathers were not consciously lubricated by the bird, Mr. Waterton based his conclusions on certain hypotheses which may be summarized as follows:

1. Much of the structure of the body plumage was such that the slightest contact with oil irreparably terminated its fluffy condition.
2. The obvious preening to which birds devote so much of their time is a necessary process in keeping the vermin population at a minimum.
3. The structure of the beak and of the tongue inhibited their use as an intermediate agent in the process of lubrication.
4. Even though it were possible so to lubricate the body plumage, the plumage of the head and neck, whose texture is indistinguishable from that of the body, could not so be lubricated.

The major points on which the proponents of the theory based their conclusions were:

[1] Read before the Fourth Annual Meeting of the Cooper Ornithological Club at Berkeley, California, May 18, 1929.

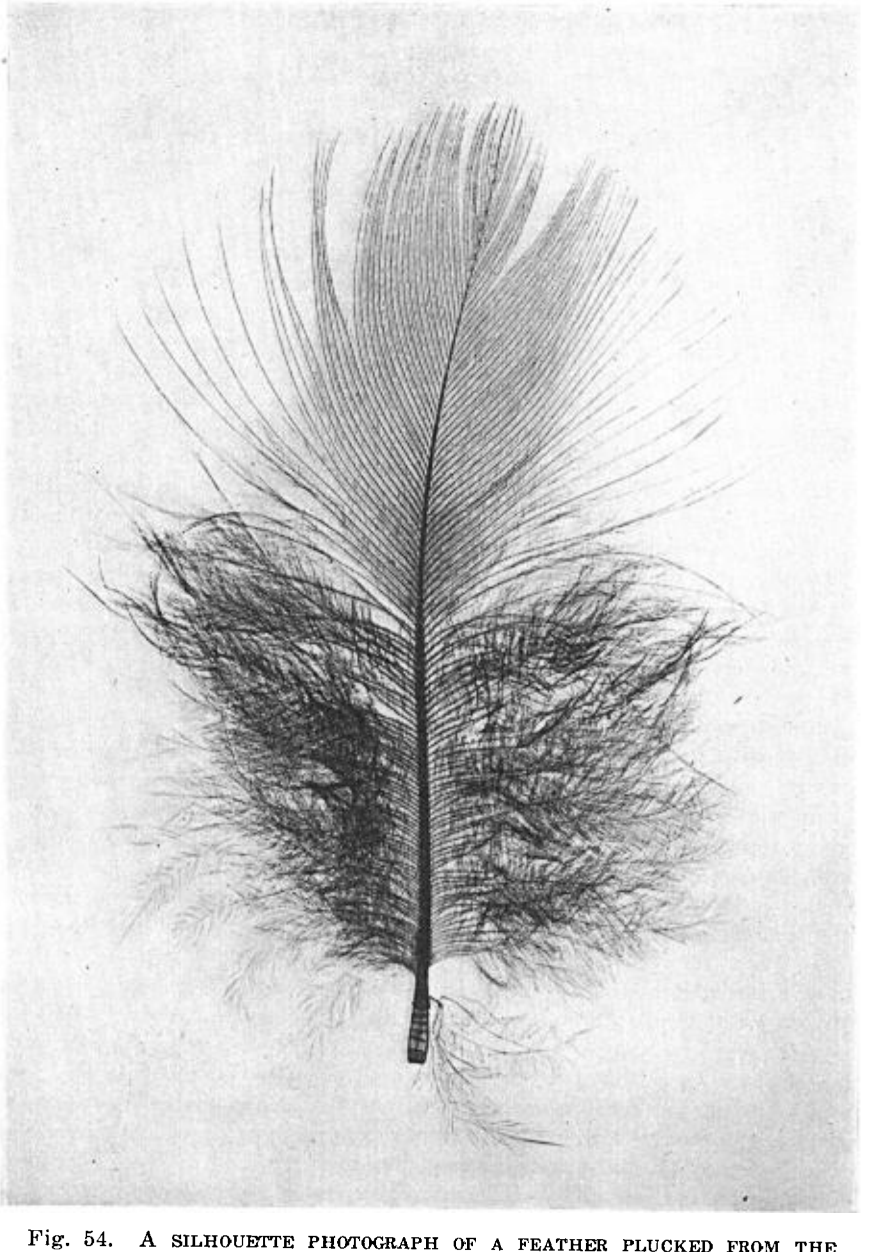


Fig. 54. A SILHOUETTE PHOTOGRAPH OF A FEATHER PLUCKED FROM THE BACK OF A WIDGEON, AT DEATH. ATTENTION IS DIRECTED TO THE PLUMULACEOUS BASAL HALF, THE DELICATE FLUFFINESS OF WHICH WOULD BE DESTROYED BY THE SLIGHTEST TAINT OF OIL. x 3.
Photograph by Joseph Dixon.

1. Observation of frequent actions of the bird in applying its beak to the vicinity of the oil-gland and then to the feathers.

2. In rebuttal of the fourth assertion above: that the bird rubbed its head and neck feathers on the body plumage, and thus lubricated them from the oil that had first been applied to the body feathers.

Mr. Waterton challenged the observations, stating that the birds cited by his opponents as having been observed in the act of oiling their feathers, had their oil-glands so submerged in down-feathers that actual contact of the beak with the gland in a way to convey oil to the beak could not be observed.

Around this controversy, thus briefly outlined, many details of similar nature were woven. Mr. Waterton's assertions had come as such a shock to the orthodox legend of the ornithological hierarchy that they were soon forogtten in a mass of recorded observations not one of which carried the matter to factual conclusion.

Feather Mount Method. My own attention was drawn to the improbability that the oil-gland furnished lubrication for the feathers after I began the method of studying feathers which I outlined in THE CONDOR (XXVII, 1925, p. 123). It excited no particular skepticism when passerine feathers, taped flat on white paper and left there for long periods, produced no oil stain on the paper sheets. But when my experience extended to other groups, including waders and water birds, and no stain appeared on the paper to which their feathers were taped, there seemed to be convincing evidence that feathers do not carry oil on their surfaces.

As the idea developed in my mind, I deliberately sought out freshly killed water birds of the various groups for the purpose of testing this oil theory, and mounted their plucked feathers tightly held against delicately surfaced sheets of paper.

The Case of the Black-vented Shearwater. As a climax, in January, 1929, Mr. George Willett was good enough to shoot and bring to me three Black-vented Shearwaters. I think of birds of the shearwater-petrel group as the oiliest of all. In collection cabinets the feathers on specimens of these forms feel oily, and labels attached to such specimens are invariably saturated with oil. Perhaps these and similar impressions have kept allayed skepticism that might otherwise have developed.

If one raises the feathers on the rump of a shearwater so that the area about the oil-gland is exposed, he finds a broad brush, nearly an inch long, mounted on the tip of the oil-gland. This brush lies flattened in the V-shaped area between the bases of the upper tail coverts. It has the appearance of a miniature tail whose plane is that of the real tail. The oil-gland itself is obscured by dense fluffy down which fairly contacts, as does the downy base of the upper coverts, the very edges of this oil-gland brush or tuft. But, marvel of marvels, the oil-gland tuft is saturated with oil so that the slightest touch leaves oil on one's finger, while the upper tail coverts and the down which surrounds the oil-gland, and the rump feathers which fairly lie on this oil-tuft in natural position, are so free from oil that they may be filed away between folds of delicate onion-skin paper and preserved flat without yielding any oil stain, except for the few shreds which had been in actual contact with the oil-tuft.

Inferential Points. From these observed facts we may draw certain logical conclusions which seem to be of value in solving this oil-gland problem. To begin with, if the oil were of an enamel-like nature, with elements of it quickly volatile so that it dried as a varnish, would we not have this oil-tuft becoming the center of a ball of dried enamel? But there is no ball of enamel. If, on the other hand, the oil were of such a nature that, once applied, it would creep over the surface of the feathers to a uniform consistency, would we not find it creeping from the oil-saturated tuft of the oil-gland of this Black-vented Shearwater to and through and over all the adjacent feathers? That the oil will creep over feathers seems certain, since the large oil-tuft of the shearwater is uniformly besmeared with it. But the oil does not creep over the feathers which surround the oil-tuft, and it is absent from all the other body feathers.

Right here, it seems to me, Nature herself takes a hand in answering the question of whether or not she wants oil on the body feathers, for in many birds whose oil-glands bear tufts, Nature seems to have gone to considerable pains to provide special skeletonized feathers which in some way insulate the oily tufts from the surrounding plumage. Why these skeletonized feathers not only do not convey oil to the feathers which overlie them but do not themselves receive oil, I have not determined.

Experiments. When we subject the feathers of a bird's body to experiments which should reveal the presence of oil, its absence becomes apparent. Pluck feathers from any part of the body of a swan or shearwater or robin, freshly killed or alive, place these feathers in a folded sheet of delicately surfaced white paper, and run a hot iron over them. If oil were present, oil spots should appear on the paper. But the paper will remain unstained, even until scorched by the iron. Again, place another such pluck of feathers in a clean test-tube filled with distilled water and boil the water over a flame. If oil were present it would rise to the surface of the water, and when cool would leave a smear on the wall of the tube. But I have been unable to detect any smear when feathers were so treated.

Waterproofness of Plumage. Rather obviously, one function of feathers is protection of the bird's body from rain. That feathers seemed to provide this protection probably gave rise to the belief that they were anointed. As we ponder on the thorough way in which plumage sheds water, we can but marvel at the peculiar fitness of the feather covering to serve that purpose without the assistance of oil. Several factors are present which tend to produce waterproofness and to prevent the saturation that would follow capillary attraction. Mode of attachment, structure, and shape of the feather, all contribute in this protective function. Enumerated, these factors which combine to produce waterproofness include:

1. The arrangement of the feathers in the pterylae. This is such that each feather overlaps the adjacent halves of two other feathers: a system of imbrication consistently followed by the man who shingles your roof.

2. The curvature of each contour feather. So convexed are their exposed surfaces that, except when raised nearly to a vertical position, the tips of the feathers curve over and engage the surfaces of the feathers under them. This feature is particularly marked in the birds which spend their time in the water, such as swans, ducks, shearwaters, and the like.

3. The cortex or hardened surface of every element of the feather. This is so glazed that fluids will not readily penetrate its unfractured surface. In other words, the structure of the cortex is, for all practical purposes, non-absorbent.

4. The crisscrossed barbules, subtly hooked together. The closeness and extreme minuteness of the strands of the pennaceous feather fabric are such that, being non-absorbent, the surface tension of water is not broken, except under pressure. By pressure I mean driving rain and contact with wet shrubbery.

5. The resilience or spring of the plumage mass. This, and the fact that all parts of the bird's body are either convex or slanting, tend to make drops of water bounce or glance off the plumage. If droplets collect, as they do in a mist, frequent shakes dislodge them.

6. The warm air-blanket which the plumage retains about the body. This probably adds to the inhospitability of the feather surface toward water.

Flatten a dry body feather on a table and let a drop of water fall on it. Note that little, if any, of the water penetrates the fabric of the feather. Each drop, or if the drop is shattered, each droplet, stands on top of the feather, a spherical bead,

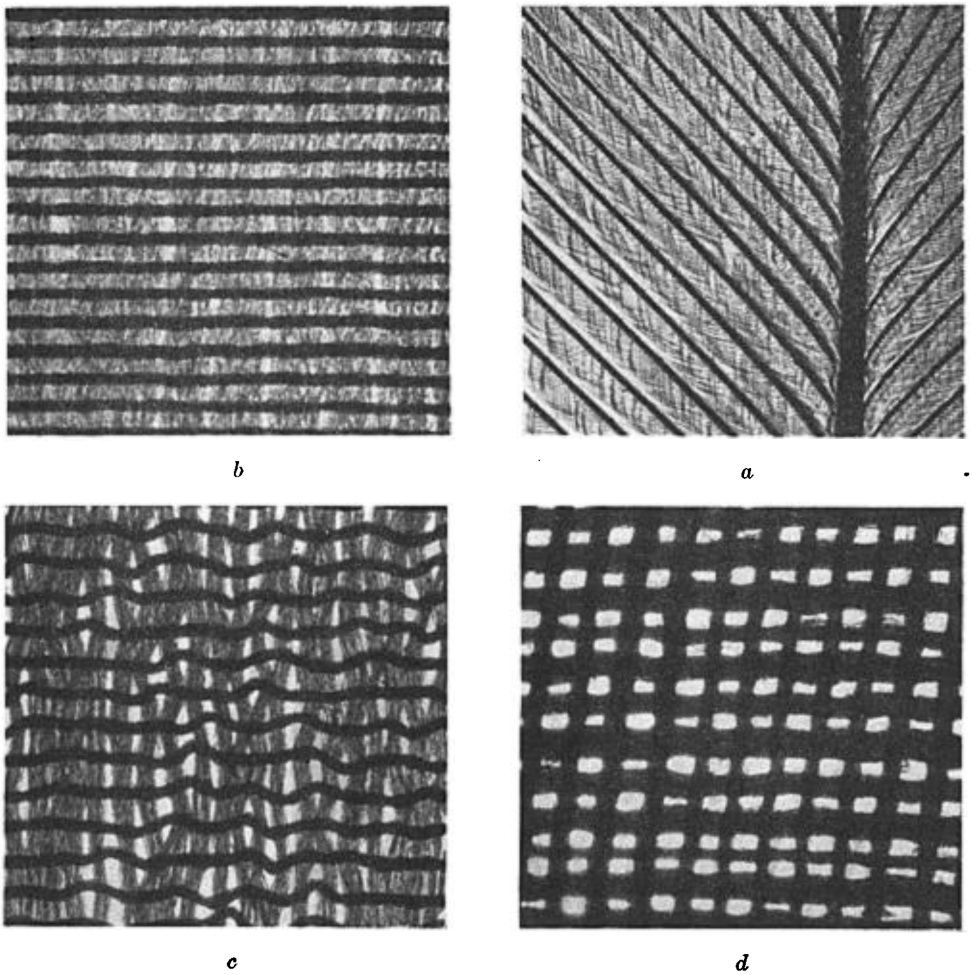
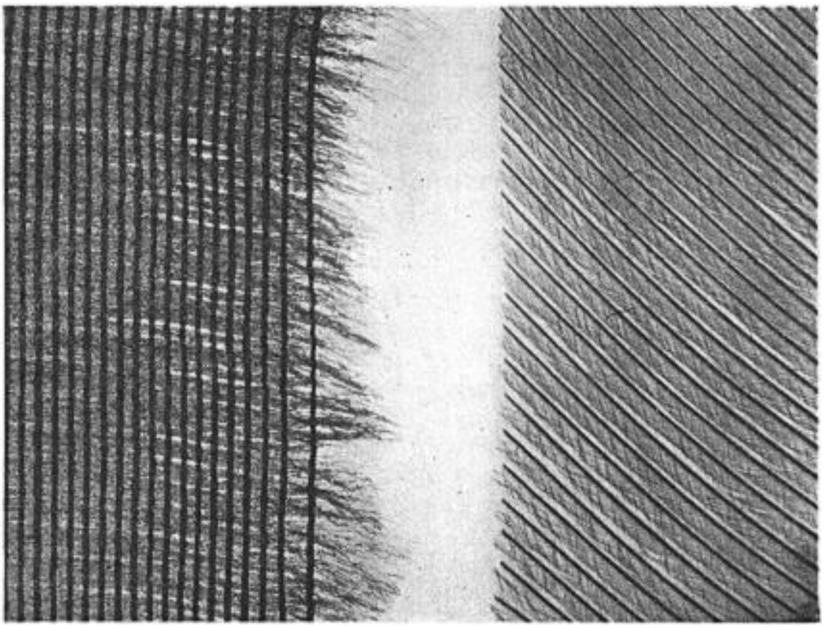


Fig. 55. A MICROPHOTOGRAPHIC COMPARISON WITH IDENTICAL MAGNIFICATIONS OF THE FABRICS OF (a) THE PENNACEOUS WEB OF A FEATHER FROM THE BREAST OF A BLACK SWAN, (b) THE PUSSY WILLOW SILK OF COMMERCE, (c) CREPE DE CHINE, AND (d) HANDKERCHIEF LINEN. THE FABRIC PRODUCED BY THE CRISSCROSSED BARBULES OF THE FEATHER IS THE FINEST OF THEM ALL. x 15.

Photograph by Claude S. Turner.

its surface tension unbroken by the feather elements. A flick of the feather, and the drop rolls off intact. One may first boil the feather if he chooses. The reaction toward water will be the same. If he holds the feather up by its calamus, a position which more nearly approximates the natural position on the bird, a drop of water which strikes it will not tarry on its curved surface.

These factors, likewise, contribute in making it possible for a bird to rest or move in water without becoming water-logged. Not only does the weight of the bird's body tend to seal up the feather mass, by compressing the convexed feathers against one another, but the mesh of each individual feather, on being flattened out, must become materially tighter. This feather mesh thus compressed is so smooth and non-absorbent that the surface tension of the water in which the bird swims is not broken. Nature has accomplished this smoothness by producing what we call "pennaceous feathers." Birds whose plumage lacks the glazing which pennaceous feathers produce become soaked by rain. Van Tyne noted this in the toucan.



a *b*

Fig. 56. SIMULTANEOUS MICROPHOTOGRAPHIC COMPARISON OF (a) THE FIBERS OF PUSSY WILLOW SILK WITH (b) THE FIBERS (BARBULES) WHICH FORM THE PENNACEOUS WEB OF A FEATHER FROM THE BREAST OF A SNOW GOOSE. THE LATTER HAS BEEN CLIPPED TO A STRAIGHT EDGE. x 9.

Photograph by Claude S. Turner

The Function of the Oil-Gland. Now, as to the actual function of the oil-gland. Not long since, I had the pleasure of handling a heron, freshly killed. In contemplating the powder-down tracts which made an oily smear when a glass slide was touched to them, it occurred to me that each of these tracts was in a position which permitted the bird readily to lay its beak against the tract. If, for instance, it turned its head so that the tomia of its beak engaged the oil-gland, the distal portions of its beak would lie against the powder-down tract on its rump. The sort of curves that a heron's neck is wont to take would bring the beak into close contact with the powder-down tracts of the breast. It might even draw its beak through the tract where the leg joins the body. And here, of a sudden, came the thought with regard to the function of the oil-gland. Could it be a lubricant for the beak?

Physiologically the tissues of a bird's beak may be likened to those of our finger-nails. At its surface the beak sheath consists, in most birds, of dry lifeless cornified tissue, the cells of which are deprived of metabolic assistance. We all know that our finger-nails show direct response to oil, water, and dry heat. Dry finger-nails become brittle and are easily cracked; nails kept oily are pliable. Now, in the economy of the bird the beak is subjected to hard use. Herons, hawks, parrots, even many passerine birds do not spare their beaks. The beak of a water bird, frequently submerged, is now wet, now dry: a most disintegrating thing for any kind of material. To keep the beak effective, then, it would seem that an external lubricant is necessary.

Does it not seem natural that Nature should supply an oil-gland, with the oil of which the beak can be lubricated and prevented from becoming brittle? For this purpose, where in the economy of the bird could a gland supplying this element be better placed than at the base of the tail? Located here, from one side or the other, with a little twisting of the head, the entire beak can be brought into conact with the oil-gland. What more natural than that the oil-gland, to serve such purpose, should be furnished with a delicate brush of specialized feathers? And finally, what more natural than that a bird should polish the oil into its beak on the ready-made polisher which its plumage affords?

In application, this function of the oil-gland can be reconciled to any type of beak, from that of a pelican to that of a hummingbird and from that of a raptor to that of a shearwater. Can we say as much for the older theory that a bird anoints its feathers? One can but be amused at the thought of a pelican, or a skimmer, or a nighthawk, or a raptor, carefully transferring oil from its oil-gland to its feathers. Nor can one believe that the marvelous fabric displayed by a feather from the back of a hummingbird or of a Violet-green Swallow can have the faintest taint of oil on it, or that the down of an eagle (perhaps the most fluffy of all down) has the slightest trace of external oil. Then there is the dainty velvet of the owl's wing. No oil there, we may be sure.

The Bloom on Feathers. In presenting this paper and supporting the theories I have advanced, I am not unmindful of the fact that the down of certain birds and the feathers of certain birds have a bloom which leaves a delicately traced design when pressed between plates of glass, but I am unwilling to believe that this bloom has anything to do with the content of the oil-gland or with oil. In fact, the slightest taint of oil must destroy this fluffy bloom.

Birds without an Oil-Gland. The species of birds which do not possess an oil-gland may be degenerate mutants headed for extinction (which I seriously doubt), or they may have acquired dependence on a type of food, the oily content of which has relieved the oil-gland of its function of lubricating the beak. Thus their oil-gland may have disappeared through disuse. In some, at least, of these birds which have no oil-gland, certain individual feathers in the body plumage are reported to have acquired a specialized condition approaching that of the powder-down of herons. I have examined some glandless parrots in the flesh, but have failed to detect any feathers which were functional for oiling purposes. Moreover, these glandless parrots are clothed in a fluffy immaculate down.

Conclusion. But this is beside the question. I have merely endeavored to substantiate Mr. Waterton's claim that the function of the oil-gland is not the lubrication of the feathers. To his cogent reasons for disbelieving the orthodox theory, I have added experimental data which indicate that oil is absent from the contour feathers of birds, and analytical data which indicate that the plumage of a bird furnishes a waterproof covering without the assistance of oil. And finally, I have suggested, as a function of the oil-gland, the lubrication of the beak.

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The bibliography which follows lists some of the articles which discuss in detail the oil-gland or its function, or which bear on the controversies which arose about them. Titles which merely mention the presence or absence of the gland have been omitted. No claim is made to completeness. I am indebted to Mr. Harold L. Leupp, Librarian of the University of California, for valuable assistance in adding titles to this list, and to Mr. Donald R. Dickey for the free use of his splendid ornithological library.

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