AN ASPECT OF COLLECTORS' TECHNIQUE

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THE following notes are not written by a histologist or a physiologist and do not pretend to describe the phenomena to the limit of our knowledge of the organs or tissues involved or to discuss the functional significance or theories of chemical control of the changes which are described. A small introductory bibliography is added, though there is little enough literature to bridge the gap between the classroom specimen or slide and the life cycle of the wild bird or mammal. The ornithologist is interested in these matters not for the sake of histological or physiological knowledge *per se,* but as steps toward the precise record and definition of life histories for such purposes as inter-specific comparison and environmental correlation. This point of view is not easily understood by the technical specialist. As one of the few, and rather shamefaced, recent recruits to the disappearing fraternity of collectors, I, like everyone else, have been impressed with the limited utility of birdskins, and have tried to develop a rudimentary system of record for a few facts which can be saved even under field conditions. As long as a great quantity of material for exclusively systematic purposes is the prime requisite, such material, involving so large a waste of life, can be put to little further use.

It may be argued that these are matters which pertain to the histologist, and that to modern science ill-standardized and incomplete records are valueless. On the other hand such records are, for untold years, the only means by which the immense numbers of wild species are going to be brought under, or contribute to, the physiological theory which is the most likely to make sense out of the welter of taxonomic, distributional, and behavioristic facts. I do know that I have many series from which perfectly reliable life cycles can be built up, while the average museum series illustrates nothing but the molts.

As far as the notebook goes, of course, the record should be limited only by the collector's knowledge, time, and equipment. But a large part of what is suggested here should go straight onto the label and remain inseparable from the skin. A great proportion of the materials upon which vertebrate zoology will depend for generations has either been collected without systematic field records or has long been separated from them, and the future holds no special promise of improvement in this respect. The minimum record with the skin should define the state of the reproductive organs and the amount of fat,

with as many of the other suggested characters as possible. The point to remember is that everything is of interest that shows a *cyclic change.*

Adequate definition of the condition of the female organs is the least ambiguous indicator of the chronology of the reproductive period. The fledgling ovary, a vague whitish body, though probably of more or less constant form, is hard to measure by gross methods, and it is better for the collector merely to indicate its quality (color, firmness) and restrict his measurements to oocytes after they begin to reach a millimeter or over. At first the ovary is hardly more than two membranes, germinal epithelium and *tunica albuginea,* attached below by its hilus and enclosing quantities of microscopic oogonia, though occasional primary oocytes are present in a month or two, and many by fall. There seems to be, in temperate regions at least, an early winter period of practically no change. In later winter or early spring, growth of new layers of connective tissue, growth of follicle cells covering the oocytes, and advanced growth phases of the primary oocytes themselves slowly create the first visible changes which the collector can and ought to record. The ovary becomes firm and cremeous, with considerable depth, and opaque, with a visibly granular surface and minute but deep folds. Microscopically, yolk-vacuoles and soon yolk droplets appear peripherally, and the latter soon show visible color in the new, measurably large, pigmented oocytes, perhaps a month before laying in small birds. About this time or shortly after, an immense increase in growth rate of the oocytes occurs—an overnight rate-change in the hen has been shown to be 25.8-fold. Failing greater refinements, the stages can at least be recorded on the label as I have done, as "no dev.," "firm," "ova to 1 mm.," "ova to 3.5 mm., pig.," and finally "vasc." for the appearance of blood vessels on the follicle, even though the convenient little word *ova* is doubtfully correct at this stage. At least in the very few cases in which cytological investigation has been applied to wild species it is in the very large oocytes, about to leave the ovary, or even in the mouth of the duct, that the maturation divisions begin, resulting in the rapid stages called secondary oocytes, ootids, and finally mature ova (Durme, 1914).

At least two or three days before the oocyte leaves the follicle, or skin of follicular cells which surrounds it, there appears on the latter a broad white line, about a quarter the diameter in length, and free of blood-vessels, the cicatrix or attenuated stigma. This splits, and the ovum is pressed out into the filmy mouth of the duct, or infundibulum. These white lips help to distinguish the subsequent col-

lapsed, emptied follicles from the degenerating undischarged follicles, which are common, so that it is easy to tell with the naked eye or hand lens, during laying or for a very few days thereafter, the number of eggs which have been laid.

For the subsequent diminishing mass of "luteal cells" which persists for a time within the ovary, it has ceased, for no very good reason, to be fashionable to use the term "corpus luteus" owing to apparent lack of the secretory function of the homologous male body, yet no other term has been substituted. Considering other crimes of terminology in the same system, such as the name "seminal vessicles" for the profoundly distinct structures of birds and mammals, this is something of a quibble. The remnants of discharged follicles are soon indistinguishable from many others which degenerated fruitlessly—scar-like points in the ovarian mass. Their dwindlng to complete absorption requires some six weeks or two months, but they are distinguishable to the eye or hand lens for less than a week. I make notes such as *"2 empty folls.; ripe folls. 7, 9, 10 mm."* Presence of the small stages is no proof of breeding, as oocytes suffer atretic breakdown throughout the year.

As far as gross appearance goes, ovaries in early stages of retrogression are difficult to describe. Oocytes and follicles seem to degenerate at the time abundantly and variously. Many turn grayish or blackish, others strong yellow—hard, granular, often irregular in form, and isolated. I got into the habit of writing "ovary gravelly" —a senseless phrase, but one somehow suggestive and unmistakable to me. I have found the restoration of an apparently uniform, fresh-textured ovary, in songbirds, to take nearly two months from the last egg.

There seems to be a brief burst of activity of the germinal epithelium shortly after laying, which produces many oogonia, some of which grow into primary oocytes. The picture is believed to remain approximately stable during the rest of the summer, with some growth and breakdown of the already-present elements. The time and nature of winter reactivation probably differ greatly with species and climates; it has its place in the adaptive scheme, and will play a large part in the natural history of the future. Bullough with his British Starlings finds renewed growth-activity (not epithelial) from October to December, leading to abortive oocytes, but the production of new oogonia was suspended at least through the autumn. These details are all microscopic, but are given here because I have so often been puzzled by finding distinctly firm, enlarged ovaries long after

any possible breeding time, and suspect that late summer or early autumn activations of a temporary character not infrequently go to a grossly visible stage. Slowly through the winter, microscopic change takes place, such as vacuolation or the increase of follicular or other cells, but macroscopic change again waits until close to breeding-time as described for the first-year birds.

Among the most spectacular of the visible, cyclic changes is that of the oviduct (female Müllerian duct), which, from a straight, transparent, scarcely-visible thread in the fledgling, develops, shortly before first reproduction, into a huge, muscular, cream-colored or pinkish, convoluted tube which I have known to exceed the intestines in volume. In spite of continual changes in its tissue-layers through the summer, fall, and winter, the great change, as in the case of the oocytes, takes place within the month before laying. The change usually is first visible posteriorly. I note "duct dev. post.," or "duct. mod., large, or max." Within two or three weeks after the last egg, in small birds, there has been completed an equally rapid collapse. Complete regression, in appearance at least, is achieved in about six weeks. There is also a slight autumnal increase in length and thickness (Bullough, 1942), corresponding to that of the oviduct, and probably a subsequent period of stability until the approach of the next ovulation. It has been shown by various workers that the cyclic change is controlled by ovarian secretions (Domm, 1939).

Fertilization almost certainly takes place about the head of the duct (infundibulum), but presents no gross manifestation. In the hen at least, ova are believed to have survived in the oviduct so that fertile eggs have been laid at least three weeks after isolation from the cock. It is quite possible that the time of receptivity in the female may be long before actual ovulation, and it is probable that the elements of courtship and mating may, in wild birds which do not ordinarily ovulate without fertilization, have much to do with stimulating ovulation. In the hen it is thought to take about twenty-two hours from ovulaton to laying if the progress is continuous, but if the egg reaches the uterus late in the day it is usually held there over night. Of this period, about three hours are spent in the upper two-thirds or albumen-secreting part of the duct, about one hour in the isthmus or short section above the uterine enlargement, and about sixteen hours in the uterus and in the process of laying. The total time in the pigeon seems almost twice as long (Harper, 1904). It is probable that great variation will be found in different groups, perhaps in correlation with the length of the duct.

The whole period of these advanced developments is much shorter than the period of full development of the male testis, which approaches its maximum size while the oocytes of the females of the same population show relatively small development and differentiation. In regard to the testis, I am fully aware that the relation of size to function, of the external appearance of the gland to content and availability of sperms (spermia, spermatozoa), is a complex matter of which we know little. A long cytological history is concealed by very simple external changes. Certainly the development of interstitial cells, which have nothing directly to do with sperm production but which have been thought to be connected with the development of secondary sexual characters, has some effect on size. None the less, present evidence indicates direct correlation between volume and spermogenetic activity, though not between either one and abundance of interstitial cells (Bissonnette, 1930; Benoit, 1922, 1923). Simple measurements of length and breadth of the larger testis ("testis 9 x 5 mm.") make possible a fair calculation of volume.

The greatest of all the cyclic changes, judged by size alone, is found in the seminal vesicles, which terminate the *vasa deferentia* posteriorly. In some but not all small birds this forms a mass which distends the whole anal region. It has been convincingly shown to be hormone-controlled, and by no means the mere result of sperm-pressure (Riddle, 1927). On incision it is the grayish, pinkish, or 'pepper-and-salt' mass about the anus. Riddle has shown that while the oviduct undergoes a percentage increase of size of some thousand per cent, the seminal vesicle shows one of some two thousand, which is probably the greatest known cyclic change except that of the horns of deer. Bates (1927) attaches great importance to it for the field worker as a better indicator of actual breeding activity than the testes. "Large testes in the males, if accompanied also by a great knot of the coiled and tangled thread-like ducts called the *vasa deferentia,* near the vent, are evidence of breeding activity at the time. If the *vasa deferentia* are not noticeable, large testes alone are not very reliable evidence of breeding, just at the time; . . ." This has appeared to me to be true in some degree, but neither Riddle nor Bullough, who have followed the developments with great care, emphasize the greater narrowness of the maximum period of the seminal vesicles.

The epoophoron, or epididymis, has a visible change, but a very slight one, like that of the *vasa deferentia* proper. It is a narrow body adhering closely to the *vasa* as they leave the testes.

The graphs of these changes, properly related to the rest of the cycle

in both sexes, will be the medium by which technical theory regarding these organs, their secretions, their hormones, and their correlations will reach the practical problems of the life histories of the great masses of wild birds, which can themselves never be subjected to the intensive methods of the laboratory or the breeding-cage.

Testes which are dull green (starlings), dull blue (thrushes), or gray (certain ducks) should be noted. This is due to deposition of pigment between the tubules of the testis, not to disease or haemorrhage, and is sometimes visible for certain parts of the cycle, sometimes for all of it in varying degrees. Its significance is not known. Differences in size or position between the pairs of the testes are apt not to be fortuitous, but consistent in the species and the stage.

The assumption and loss of fat, especially (in our almost complete ignorance of the south-temperate region) by migrants which make long flights to and from the north, is a far more regular and significant phenomenon than is generally realized. I have always found that collectors who have not begun to work in the late winter or very early spring north of, say, 52° N. lat., have an inadequate idea of how much fat a bird may carry, as well as of the speed and regularity with which it is assumed and lost, as suggested, for instance, by the rarity of taking a really fat bird on its wintering grounds until the very end of its southern sojourn, the heavy fat of such migrants during the latter parts of their northward journeys, and its immediate loss upon arrival. That there is a cycle which is largely independent of such factors as better or poorer living is quite certain. I have no precise measure of degree of fatness and can imagine none applicable to field work, but the following verbal scale, which I have applied to a few thousand specimens, is a long way better than nothing: "no fat," "little fat," "mod. fat," "fat," "very fat," "excess. fat." I am often told that I cannot retain a consistent mental grasp of so many and such vague steps. On the contrary, I continually fight against the seeming necessity of interpolations. A more trenchant criticism would be that different groups cannot be made comparable. This is true, and is the chief reason for not using a measurement of the amount of fat at some definite point. A grebe or an auk which ought to be indicated as thin possesses a layer of fat which might make a collector accustomed to passerine birds place it two or three steps up the scale. I have no answer to this except to ask the hypothetical critic to suggest something better. In practice, I do make allowances for loons, grebes, and most pelagics, but do not draw distinctions between perching birds of different fat-carrying tendencies—that is,

I judge northern savannah sparrows, which perhaps top my personal list, by the same standards I apply to northern resident jays, kinglets, or chickadees which are seldom fat. Most ducks can become really thin and come under the system fairly well, though I do not claim that the designations would reflect comparable conditions of the birds, as compared to other groups, very precisely. It must be remembered that the indications cover sections on an imaginary ordinate, not absolute states. Thus, "no fat" does not mean that there may not be a light smear of yellow in the dorsal tract.

No fat.—Hardly more than a hint in the dorsal tract or about the pygostyle.

Little fat.—A substantial depth, perhaps a millimeter in a sparrow, in the dorsal tract. Some fat in the furcula.

Moderate fat.—Quite heavy in the tracts, with small plates elsewhere on the skin. Crotch of the furcula fairly well filled.

Fat.—Moderate sheets removable as such from many parts of the skin.

Very fat.—Considerable amounts of solid fat inside the abdominal cavity, filling in between the intestinal folds, but the latter not hidden or embedded.

Excessively fat.—Deep sheets of fat everywhere between skin and muscle, even over the back. Intestines solidly embedded and overlaid, hardly visible. I have found the easily detachable fat on newly arriving savannah sparrows and shrikes in the north to weigh as much as one-fifth of the weight of the bird.

This scale has been used and published by Blanchard (1941).

Another matter of interest, already mentioned in connection with the *vasa deferentia,* is the appearance of the vent, and this is of special interest to bird banders, as in the live bird it may reveal sex with fair certainty at an important time, as well as something of imminent or recent laying in the female or readiness to mate in the male. Not only in the male, but in both sexes, the surrounding tissues are apt to rise in a protuberance, definitely in a round column in the male, less certainly and in a less elevated, transversely oval mass in the female. The vent itself is more apt to show as a round orifice in the male, as a transverse slit in the female. The elevation in the female, when present, is probably due in large part to the crowding of the duct and the pressure of the heavy uterus.

There is no worse illustration of our failure to make use of opportunities or to learn anything of a bird's life from skin-collecting than our ignorance of the history and correlations of the brood-patch. The patch is by no means a mere removal of feathers, but an elaborate and deep-seated physiological process involving spectacular anatomical changes. The sequence of external manifestations would serve to reveal the condition of the bird and the stages of the hidden cycles with fair accuracy. The nature of the gradual baring of the skin, its as-

sumption of the heavy, pulpy, quality, the accumulation of underlying liquid, and the disappearance of all these characters ought to be recorded precisely.

Bernhard Lange's long paper on the subject (1928), while it does describe and illustrate the highly complex forms and locations of the patch in half a dozen types, is almostly entirely concerned with the involved changes in blood vessels, with difficult and far-fetched analogies, such as with the apparatus involved in mammillary developments in mammals, and with the highly complex histology of the skin changes.

In most of the smaller and higher forms, the process seems to be quite involuntary, though perhaps aided by wear. The presence of almost completely bare patches, though without full development otherwise, in some non-brooding passerine males, was apparently not realized by that superb student of pterylography, Christian Ludwig Nitzsch, who, unfortunately, wrote very little about the matter. There seems not to be much doubt that certain of the larger and lower forms, such as some ducks and geese, which use their own feathers in their nests, remove them, whether or not previously loosened, with their bills. To what extent this is true elsewhere we do not know. Personally, I have little doubt that it is true of loons and grebes which do not make use of the feathers. I have collected a Red-throated Loon which had just laid its eggs, with a small, uncompleted patch, bounded by feathers which showed neither special wear nor loosening, and I suspect that this bird tears out its feathers by force. Nitzsch says: "I have most certainly seen the two brood-spots ascribed by this writer [Faber] to the species of *Phalaropus* . . . and have convinced myself of the spontaneous shedding of the down-feathers at this spot. This may also be the case with the contour feathers, when these are wanting at the period of incubation, as in the owls (see that family). The birds may, however, in some cases pull out the feathers which have already become loose, and thus assist in the production of the brood spots."

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NOTES ON THE CHIMNEY SWIFT

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FLIGHT

DURING the course of my banding work among Chimney Swifts (*Chaetura pelagica*) at Swarthmore College, I discovered three occupied chimneys on Beardsley Hall and made the following observations. These chimneys were closed at the top by large overhanging stone slabs, and the birds had to enter through 'windows' in the four sides of the chimneys. Inasmuch as swifts usually roost and nest in chimneys which are open at the top, it was necessary for these birds to modify their usual mode of entry.