

EDWARD JENNER, PIONEER STUDENT OF TWO MAJOR ORNITHOLOGICAL PROBLEMS

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WHILE von Pernau (1660–1731), whose work Stresemann (1947) has compared to that of Altum, Heinroth, and Eliot Howard, was clearly the pioneer student of bird behavior in the early 18th century, Edward Jenner (1749–1823) was a pioneer of the late 18th century whose talents for seeing problems, asking questions, and performing simple experiments entitle him to be considered, as far as method goes, as being a predecessor of Darwin and Tinbergen. As with von Pernau, Jenner's contributions were overlooked by many. This was due in his case to the overriding acclaim resulting from his discovery of vaccination, a discovery, incidentally, that came only after years of the same kind of patient field observations and experiments that characterized his bird studies. It should not be forgotten, however, that it was his "Observations on the natural history of the Cuckoo" (1788) that had won him membership in the Royal Society 10 years before. His work on bird migration, although done at about the same time, was not published until after his death in 1823. Both of these papers were landmarks in ornithological history, for no one prior to Jenner had approached these problems, of brood parasitism and migration, in anywhere near so comprehensive a fashion or with such searching questions.

Jenner was born in the vicarage of Berkeley, Gloucestershire, in 1749. Although the son of Rev. Stephen Jenner, who died when Edward was five, and brought up by his eldest brother, who was also a clergyman, his writings, unlike those of von Pernau and earlier 18th century naturalists, are remarkably free of references to God or to theology. They are straightforward and in the modern vein. Like most great naturalists, Jenner's interests in natural history were well begun by the time of school age when he was known to have collected fossils as well as the nests of dormice. At 13 he was apprenticed to a local surgeon and at 20 went to London to live for 2 years with John Hunter (1728–1793), an extraordinarily versatile and original man, devoted to the idea that natural history should be the basis for discoveries in medicine and surgery. Hunter not only applied this idea with success, for he was the founder of modern surgery, but also had a succession of great students. Among these Jenner was his favorite. After Jenner returned to Berkeley, being devoted like Gilbert White (1720–1773) to the district where he had grown up, he continued for over 20 years to exchange letters on problems of natural history with Hunter.

It was while Jenner was in London that Captain Cook returned from his first voyage. Sir Joseph Banks, naturalist of the expedition and later president of the Royal Society, asked Jenner to prepare and arrange the vast collections brought back from the voyage and so successful was he that he was invited to be the naturalist on Cook's second expedition. Jenner, however, may have already seen that he had greater work to do in Gloucestershire.

It was in response to a request from Hunter that Jenner first began, as he writes, to "employ some of [his] leisure hours attending to the natural history of the cuckoo" which, as a classic of field investigation, furnishes a model as fresh today as it was nearly 200 years ago. One might read the account in cursory fashion and exclaim "this is all well known today." On the other hand, if the account is followed in detail, with an eye to how Jenner saw problems and went about solving them, then the skill involved becomes apparent.

Jenner begins by noting, among other things, that the Cuckoo (*Cuculus canorus*) arrives about the 17th of April; that the female has an obscure song that is little known, and that she is usually attended by two or three males when in flight. She does not begin to lay eggs until some weeks after her arrival. Although she may choose a nest from a variety of fosterers, she shows preference for the nests of the Hedge Sparrow (*Prunella modularis*), on which Jenner concentrates his observations. He first finds that the Cuckoo lays its egg at a time when the Hedge Sparrow has laid one or two and that the Cuckoo's egg commonly hatches first. It was well-known at the time that the young Cuckoo became the sole occupant of the nest shortly after hatching. No one, however, had sat down to find out how this came about. A common conjecture was that the old Cuckoo returned to toss out the young Hedge Sparrows, but Jenner, who had an eye to the whole natural history of the bird he was studying, soon perceived from a natural experiment that this could not be so. This was based on observations of some nests where the young Cuckoos hatched in July after the old ones had departed. In these cases events were no different, for the young Hedge Sparrows were still evicted. Some other factor, therefore, must be operative.

Jenner's investigations were only partially successful in 1786. On the 20th of June he found a Cuckoo that had just hatched, while below the nest lay a young Hedge Sparrow, dead, and an egg with a live chick inside. Jenner returned the egg, but found it thrown out a few minutes later. He now removed the young Cuckoo, and when he returned three-quarters of an hour later the chick had hatched and was being fed by its parents. He replaced the Cuckoo and shortly afterward the hatchling Hedge Sparrow was again evicted. The nest, however, was deep in a

hedge. Jenner could not believe at the time that anything so feeble in appearance as the newly-hatched Cuckoo could clear the nest and he supposed that the evictions were carried out by the adult fosterers.

It was on the 18th of June in the following year that Jenner made his great discovery in a nest that was better situated for observation. It was then he saw, to his astonishment, the young Cuckoo in the act of turning out its nest mate. In his own words, "the little animal, with the assistance of its rump and wings, contrived to get the bird upon its back, and making a lodgement for the burden by elevating its elbows, clambered backward with it up the side of the nest till it reached the top, where resting for a moment, it threw off its load with a jerk, and quite disengaged it from the nest."

Jenner's initial discovery was of a remarkable instinct present at birth. He then went on to note that, coupled with it, the young Cuckoo had "a very broad and considerable depression" in the middle of its back suited to holding either the egg or the nestling Hedge Sparrow. His next question was how long might this instinct persist. By adding eggs or young from other nests he found that the young Cuckoo would throw out eggs until 10 days or nestlings until 12 days at which time the depression in the back had filled in.

Another adaptation observed by Jenner was use of the wing tips as feelers. Continuing his description from where the young Cuckoo rested at the rim of the nest, he writes "It remained in this situation a short time, feeling about with the extremities of its wings, as if to be convinced whether the business was properly executed, and then dropped into the nest again. With these (the extremities of its wings) I have often seen it examine, as it were, an egg and nestling before it began its operations; and the nice sensibility which these parts appeared to possess seemed sufficiently to compensate the want of sight, which as yet it was destitute of." Here again, one might add, his writing is a model of brevity.

An observation that had escaped other naturalists was the smallness of the Cuckoo's egg. Whereas the adult was five times the size of the Hedge Sparrow, its eggs were slightly smaller than those of the fosterer, weighing from 43 to 55 grains. Jenner then asks why the Cuckoo should select the nests of birds smaller than itself. His reasoning is that there are many more nests of small birds than of large ones, and hence small birds such as the Hedge Sparrow can better sustain the loss of their young. Jenner, having come thus far in reasoning, now asks the major question concerning the Cuckoo of "why, like other birds, it should not build a nest, incubate its eggs and rear its own young?" As indicated below, Jenner was equipped both by his interest in anatomical dissections as well as in bird migration to provide a reasonable answer.

Jenner begins his inquiry by stating that although the Cuckoo arrives in April its eggs are not ready for incubation before the middle of May. If one adds up the times of a fortnight for incubation, 3 weeks for care in the nest, plus 5 weeks that the foster parents continue to feed a young cuckoo after fledging, it is apparent that the young do not become independent until well into July after their parents have left. The adult Cuckoos, therefore, are in residence for too short a time to raise their own young. This, Jenner believed, was one reason for their habit of using the nests of other birds.

The thoroughness of Jenner's inquiry is brought out in the way he resorts to dissections as well as comparisons with other avian species to help answer questions arising from his field studies. After making the observation that in going from one nest to another to lay an egg, a Cuckoo is in the same state of losing the stimulus for incubation "as the bird whose nest we daily rob of an egg," Jenner proceeds to examine the ovaries of Cuckoos at different stages of the breeding season. Here he compares the Cuckoo that is beginning to lay with a pullet, the oviduct of each containing an egg ready to be laid and ovaries having large clusters of eggs that are well-advanced. It was evident from dissection therefore that the Cuckoo probably laid many eggs and not just a few as was commonly believed. These observations led Jenner to conjecture that a Cuckoo can "retard or bring forward her eggs . . . in obedience to the dictates of her own will."

In his later paper on bird migration Jenner (1824) adds an additional reason for the parasitic habit in noting that "the wide dispersion of its young ones (being placed singly in the nests of other birds) gives them such security as almost to preclude the possibility of their general destruction."

Jenner's work on the Cuckoo received recognition in his own day by being quoted with admiration by Colonel Montagu (1831) whose "Ornithological dictionary" first appeared in 1802. Alfred Newton, at the end of the century (1896), stated that although others had sought to impugn Jenner's accuracy, his observations had "been corroborated by others in the minutest detail." Much the same is also stated by Baker (1942) in his book called "Cuckoo problems." Jenner's interest in the peculiarities of the early migration of the Cuckoo may have been what led him to his second work, a broad study of the question of migration itself.

His paper on the migration of birds (1824) is the first clear exposition of the reality of migration, along with some of the principal reasons for it to appear in the modern era. It is more discursive than the Cuckoo paper, probably because he did not prepare it for the publication

that came after his death. Many naturalists of his time, including Gilbert White, believed that swallows and swifts hibernated under water. This seemed improbable to Jenner. He had been studying hibernation in hedgehogs (in conjunction with Hunter), and had noted that they approached the winter "with vast stores of fat" that, by the end of the winter, are "exhausted and the animal comes forth thin and emaciated." The situation with migrants, however, is extremely different. If a martin or swift be examined "on the first day of its appearance it will be found as plump and fleshy" as any time during its stay. It seemed unlikely, therefore, that they had taken a "dreary plunge" into the mud of some pond months before. The study of body fat in relation to migration has come a long way in our time. Jenner's account, however, makes it clear that he had a notion of its importance.

He next goes on to consider the remarkable fact that swallows, and probably other birds, returned each year to the same locality. Wishing "to ascertain this with precision" he procured some swifts and "by taking off two claws from the foot of twelve," as he writes, "I fixed upon them an indelible mark." He was able to recover marked swifts from the same farm for several years, and 7 years later a dead swift with two cut toes was brought in by a cat.

Jenner would appear to have been original in his idea of marking birds. Lack (1956), who devotes a number of sentences in his book "Swifts in a tower" to praise of Jenner's work, states that Jenner was preceded by Johann Frisch who put red threads on the legs of swallows thinking that the red dye would come off if they went into the water to hibernate. It is doubtful if Jenner could have known of this work. His experiment seems a more reasonable one from a modern point of view. He had already experimented with the question of swifts hibernating by plunging one under water, proving his point that these birds had no physiological adaptations for surviving. Even diving birds, he noted, did not long survive when caught in the nets of fishermen. Jenner had marked his swifts to prove that they would return to the same locality. He then goes on to ask why they should do so. His conclusion is that if they did not, some regions could be overcrowded and others left desolate.

Jenner now attends to what he considers the "true cause of migration." Although the idea of hormones was not to develop until a century later, he noted that at the coming of spring "the voice, the gesticulation, and the attachment which the male begins to show to the female plainly indicate some new agency acting upon the constitution." This same influence, exerting itself on birds seen at home, also acts on those that have migrated and are about to return: "It is the preparation

which nature is making for the production of an offspring by a new arrangement in the structure of the sexual organs, (viz) the enlargement of the testes in the male and the ovaries in the female." With this impulse birds migrate to countries where they can better raise their young. Here Jenner's view differs from an earlier one of Mark Catesby (1747) who stated of birds that "the want of food seems to be the chief if not the only reason of their migration." Jenner, however, felt that the adult bird could well feed itself in the land from which it departed. Birds wintering in England, for example, such as Fieldfares (*Turdus pilaris*) migrated north in spring when there was actually more food present than in the winter. It seemed to him, therefore, that birds migrated to a land where they could find an abundance of the kind of food needed to raise young. He here gives details of how the type of food, gnats or small beetles, is varied to suit the age of small nestlings.

In regard to the enlargement of the gonads, Jenner and his colleague Hunter anticipated the later investigations of Rowan (1931) although the latter does not mention either of them in his book "The riddle of migration." One might raise the question of how much of Jenner's originality was due to Hunter. Actually both men were highly original and Hunter, who was less of a field naturalist, received fully as much as he gave.

Jenner's paper on migration contains many astute observations, not given here, that further strengthen his argument. As in his investigation of the Cuckoo, the main problem is always clearly in mind. He was able to make sense out of what he saw and to ask the right questions. He deserves recognition in the history of ornithology not only for having written the first comprehensive papers on two problems that are far from settled today, namely brood parasitism and migration, but also in providing a model of how field investigations in bird behavior might be carried out. It is this last aspect, especially, that has been little stressed.

In conclusion one might say of Jenner what Stresemann (1947) said of von Pernau, that he "had practically all the boundless freedom of the first explorer." A really original observer, however, can have this freedom in any age. Like Pernau, Jenner went beyond the mere descriptive in endeavoring to find out "the causes of behavior, using as his methods comparison or experiment or both together." It would be a mistake, however, to characterize him as a modern scientist. As a naturalist he was, like Pernau, a product of the "Age of Enlightenment," his work on migration, for example, including a digression on the songs of birds at daybreak and their part in "harmonizing some of the most beautiful and interesting scenes in nature." Jenner, in fact, was also a poet. Like others of the Enlightenment, including Gilbert White as well as Pernau,

he was a man of many talents, knowing well how to employ his leisure time.

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