

APPENDIX.

A POSTHUMOUS ESSAY ON INSTINCT,

BY

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APPENDIX.

[The full text of a part of Mr. Darwin's chapter on Instinct written for the "Origin of Species," but afterwards suppressed for the sake of condensation.]

Migration.—The migration of young birds across broad tracts of the sea, and the migration of young salmon from fresh into salt water, and the return of both to their birth-places, have often been justly advanced as surprising instincts. With respect to the two main points which concern us, we have, firstly, in different breeds of birds a perfect series from those which occasionally or regularly shift their quarters within the same country to those which periodically pass to far distant countries, traversing, often by night, the open sea over spaces of from 240 to 300 miles, as from the north-eastern shores of Britain to Southern Scandinavia. Secondly, in regard to the variability of the migratory instinct, the very same species often migrates in one country and is stationary in another; or different individuals of the same species in the same country are migratory or stationary, and these can sometimes be distinguished from one another by slight differences.* Dr. Andrew Smith has often remarked to me how inveterate is the instinct of migration in some quadrupeds of S. Africa, notwithstanding the persecution to which they are in consequence subjected: in N. America, however, persecution has driven the Buffalo within

* Mr. Gould has observed this fact in Malta, and in Tasmania in the southern hemisphere. Bechstein (*Stubenvögel*, 1840, s. 293) says that in Germany the migratory and non-migratory Thrushes can be distinguished by the yellow tinge of the soles of their feet. The Quail is migratory in S. Africa, but stationary in Robin Island, only two leagues from the continent (*Le Vaillant's Travels*, vol. i, p. 105): Dr. Andrew Smith confirms this. In Ireland the Quail has lately taken to remain in numbers to breed there (W. Thompson, *Nat. Hist. of Ireland*, vide "Birds," vol. ii, p. 70).

a late period* to cross in its migrations the Rocky Mountains; and those "great highways, continuous for a hundred miles, always several inches, sometimes several feet in depth," worn by migrating buffaloes on the eastern plains, are never found westward of the Rocky Mountains. In the United States, swallows and other birds have largely extended, within quite a late period, the range of their migrations.†

The migratory instinct in Birds is occasionally lost; as in the case of the Woodcock, some of which have totally, without any assignable cause, taken to breed and become stationary in Scotland.‡ In Madeira the first arrival of the Woodcock is known,§ and it is not there migratory; nor is our common Swift, though belonging to a group of birds almost emblematical of migration. A Brent Goose, which had been wounded, lived for nineteen years in confinement; and for about the first twelve years, every spring at the migratory period it became uneasy, and would, like other confined individuals of the species, wander as far northwards as possible; but after this period "it ceased to exhibit any particular feeling at this season."|| So that we have seen the migratory impulse at last worn out.

In the migration of animals, the instinct which impels them to proceed in a certain direction ought, I think, to be distinguished from the unknown means by which they can tell one direction from another, and by which, after starting, they are enabled to keep their course in a dark night over the open sea; and likewise from the means—whether some instinctive association with changing temperature, or with want of food, &c.—which leads them to start at the proper period. In this, and other cases, the several parts of the

* Col. Frémont, *Report of Exploring Expedition*, 1845, p. 144.

† See Dr. Bachman's excellent memoir on this subject in *Silliman's Philosoph. Journ.*, vol. 30, p. 81.

‡ Mr. W. Thompson has given an excellent and full account of this whole subject (see *Nat. Hist. of Ireland*, "Birds," vol. ii, pp. 247-57), where he discusses the cause. There seems reason to believe (p. 254) that the migratory and non-migratory individuals can be distinguished. For Scotland see St. John's *Wild Sports of the Highlands*, 1846, p. 220.

§ Dr. Heineken in *Zoological Journal*, vol. v, p. 75. See also Mr. E. V. Harcourt's *Sketch of Madeira*, 1851, p. 120.

|| W. Thompson, *loc. cit.*, vol. iii, p. 63. In Dr. Bachman's paper just referred to cases of Canada geese in confinement periodically trying to escape northward are given.

problem have often been confused together under the word instinct.* With respect to the period of starting, it cannot of course be memory in the young cuckoos' start for the first time two months after their parents have departed: yet it deserves notice that animals somehow acquire a surprisingly accurate idea of time. A. d'Orbigny shows that a lame hawk in S. America knew the period of three weeks, and used at this interval to visit monasteries when food was distributed to the poor. Difficult though it may be to conceive how animals either intelligently or instinctively come to know a given period, yet we shall immediately see that in some cases our domestic animals have acquired an annual recurring impulse to travel, extremely like, if not identical with, a true migratory instinct, and which can hardly be due to mere memory.

It is a true instinct which leads the Brent Goose to try to escape northwards; but how the bird distinguishes north and south we know not. Nor do we know how a bird which starts in the night, as many do, to traverse the ocean, keeps its course as if provided with a compass. But we should be very cautious in attributing to migratory animals any capacity in this respect which we do not ourselves possess; † though certainly in them carried to a wonderful perfection. To give one instance, the experienced navigator Wrangel‡ expatiates with astonishment on the "unerring instinct" of the natives of N. Siberia, by which they guided him through an intricate labyrinth of hummocks of ice with incessant changes of direction; while Wrangel "was watching the different turns compass in hand and trying to reason the true route, the native had always a perfect knowledge of it instinctively." Moreover, the power in migratory animals of keeping their course is not unerring, as may be inferred from

* See E. P. Thompson on the *Passions of Animals*, 1851, p. 9; and Alison's remarks on this head in the *Cyclopædia of Anatomy and Physiology*, article "Instinct," p. 23.

† [I cannot refrain from drawing attention to the superiority of scientific method and philosophical caution here displayed as contrasted with Professor Hæckel's views on the same subject, which in presence of this difficulty at once conclude in favour of some mysterious additional sense (see p. 95).—G. J. R.]

‡ *Wrangel's Travels*, Eng. trans., p. 146. See also Sir G. Grey's *Expedition to Australia*, vol. ii, p. 72, for interesting account of the powers of the Australians in this same respect. The old French missionaries used to believe that the N. American Indians were actually guided by instinct in finding their way.

the numbers of lost swallows often met with by ships in the Atlantic: the migratory salmon, also, often fails in returning to its own river, "many Tweed salmon being found in the Forth." But how a small and tender bird coming from Africa or Spain, after traversing the sea, finds the very same hedge-row in the middle of England, where it made its nest last season, is truly marvellous.*

Let us now turn to our domesticated animals. Many cases are on record of animals finding their way home in a mysterious manner, and it is asserted that Highland sheep have actually swum over the Frith of Forth to their home a hundred miles distant;† when bred for three or four generations in the lowlands, they retain their restless disposition. I know of no reason to doubt the minute account given by Hogg of a family of sheep which had a *hereditary propensity* to return at the breeding season to a place ten miles off, whence the first of the lot had been brought; and, after their lambs were old enough, they returned by themselves to the place where they usually lived; so troublesome was this inherited propensity, associated with the period of parturition, that the owner was compelled to sell the lot.‡ Still more interesting is the account given by several authors of certain sheep in Spain, which from ancient times have annually migrated during May from one part of the country to another distant four hundred miles: all the authors§ agree that "as soon as April comes the sheep express, by curious uneasy motions, a strong desire to return to their summer habita-

* The number of birds which by chance visit the Azores (Consul C. Hunt, in *Journ. Geograph. Soc.*, vol. xv, Pt. 2, p. 282), so distant from Europe, is probably in part due to lost directions during migration: W. Thompson (*Nat. Hist. of Ireland*, "Birds," vol. ii, p. 172) shows that N. American birds, which occasionally wander to Ireland, generally arrive at the period when they are migrating in N. America. In regard to Salmon, see *Scope's Days of Salmon Fishing*, p. 47.

† *Gardener's Chronicle*, 1852, p. 798: other cases are given by *Youatt on Sheep*, p. 377.

‡ Quoted by Youatt in *Veterinary Journal*, vol. v, p. 282.

§ Bourgoanne's *Travels in Spain* (Eng. trans.), 1789, vol. i, pp. 38-54. In Mills' *Treatise on Cattle*, 1776, p. 342, there is an extract of a letter from a gentleman in Spain from which I have made extract. *Youatt on the Sheep*, p. 153, gives references to three other publications with similar accounts. I may add that von Tschudi (*Sketches of Nature in the Alps*, Eng. trans., 1856, p. 160) states that annually in the spring the cattle are greatly excited, when they hear the great bell which is carried with them; well knowing that this is the signal for their "approaching migration" to the higher Alps.

tions." "The unquietude," says another author, "which they manifest might in case of need serve as an almanack." "The shepherds must then exert all their vigilance to prevent them escaping," "for it is a known truth that they would go to the very place where they had been born." Many cases have occurred of three or four sheep having started and performed the journey by themselves, though generally these wanderers are destroyed by the wolves. It is very doubtful whether these migratory sheep are aborigines of the country; and it is certain that within a comparatively recent period their migrations have been widely extended: this being the case, I think there can hardly be a doubt that this "natural instinct," as one author calls it, to migrate at one particular season in one direction has been acquired during domestication, based no doubt on that passionate desire to return to their birth-place which, as we have seen, is common to many breeds of sheep. The whole case seems to me strictly parallel to the migrations of wild animals.

Let us now consider how the more remarkable migrations could possibly have originated. Take the case of a bird being driven each year, by cold or want of food, slowly to travel northward, as is the case with some birds; and in time we may well believe that this compulsory travelling would become an instinctive passion, as with the sheep in Spain. Now during the long course of ages, let valleys become converted into estuaries, and then into wider and wider arms of the sea; and still I can well believe that the impulse which leads the pinioned goose to scramble northward would lead our bird over the trackless waters; and that, by the aid of the unknown power by which many animals (and savage men) can retain a true course, it would safely cross the sea now covering the submerged path of its ancient land journey.*

* I do not suppose that the line of migration of birds always marks the line of formerly continuous land. It is possible that a bird accidentally blown to a distant land or island, after staying some time and breeding there, might be induced by its innate instinct to fly away, and again to return there in the breeding season. But I know of no facts to countenance the idea; and I have been much struck in the case of oceanic islands, lying at no excessive distance from the mainland, but which from reasons to be given in a future chapter I do not believe have ever been joined to the mainland, with the fact that they seem most rarely to have any migratory birds. Mr. E. V. Harcourt, who has written on the birds of Madeira, informs me that there are none in that island; so, I am informed by Mr. Carew Hunt, it is in the

[I will give one case of migration which seemed to me at first to offer especial difficulty. It is asserted that in the extreme north of America, Elk and Reindeer annually cross, as if they could smell the herbage at the distance of a hundred miles, a tract of *absolute* desert, to visit certain islands where there is a better (but still scanty) supply of food. How could their migration have been first established? If the climate formerly had been a little more favourable, the desert a hundred miles in width might then have been clothed with vegetation sufficient to have just tempted the quadrupeds over it, and so to have found out the more fertile northern islet. But the intense Glacial preceded our present climate, and therefore the idea of a former better climate seemed quite untenable; but if those American geologists are right who believe, from the range of recent shells, that subsequently to the Glacial period there was one slightly warmer than the present period, then perhaps we have a key to the migration across the desert of the Elk and Reindeer.*]

Instinctive Fear.—I have already discussed the hereditary tameness of our domestic animals; from what follows I have no doubt that the fear of man has always first to be acquired in a state of nature, and that under domestication it is merely lost. In all the few archipelagoes and islands inhabited by man, of which I have been able to find an early account, the native animals were entirely void of fear of man: I have ascertained this in six cases in the most distant parts of the world, and with birds and mammals of the most different kinds.† At the Galapagos Islands I pushed a hawk off a

Azores, though he thinks that perhaps the Quail, which migrates from island to island, may leave the Archipelago. [In pencil it is added "Canaries none."—G. J. R.]

In the Falkland Islands, so far as I can find, no *land-bird* is migratory. From enquiries which I have made, I find there is no migratory bird in Mauritius or Bourbon. Colenso asserts (*Tasmanian Journal*, vol. ii, p. 227) that a cuckoo, *C. lucidus*, is migratory, remaining only three or four months in New Zealand; but New Zealand is so large an island that it may very easily migrate to the south and remain there quite unknown to the natives of the north. Farøe, situated about 180 miles from the north of Scotland, have several migratory birds (Graber, *Tagebuch*, 1830, s. 205); Iceland seems to be the strongest exception to the general rule, but it lies only _____ miles from the _____ line of _____ 100 fathoms. [The last ten words are added in pencil with the blanks left for subsequent filling in.—G. J. R.]

* [The paragraph which I have enclosed in square brackets is faintly struck out in pencil.—G. J. R.]

† I have given in my *Journal of Researches* (1845), p. 378, details on the Falkland and Galapagos. Mr. Cada Mosto (*Kerr's Collection of Voyages*,

tree with the muzzle of my gun, and the little birds drank water out of a vessel which I held in my hand. But I have in my "Journal" given details on this subject, and I will here only remark that the tameness is not general, but special towards man; for at the Falklands the geese build on the outlying islands on account of the foxes. These wolf-like foxes were here as fearless of man as were the birds, and the sailors in Byron's voyage, mistaking their curiosity for fierceness, ran into the water to avoid them. In all old civilized countries the wariness and fear of even young foxes and wolves are well known.* At the Galapagos Islands the great land lizards (*Amblyrhynchus*) were extremely tame, so that I could pull them by the tail; whereas in other parts of the world *large* lizards are wary enough. The aquatic lizard of the same genus lives on the coast, is adapted to swim and dive perfectly, and feeds on submerged algæ: no doubt it must be exposed to danger from the sharks, and consequently, though quite tame on the land, I could not drive them into the water, and when I threw them in they always swam directly back to the shore. See what a contrast with all amphibious animals in Europe, which when disturbed by the most dangerous animal, man, instinctively and instantly take to the water.

The tameness of the birds at the Falklands is particularly interesting, because most of the very same species, more especially the larger birds, are excessively wild in Tierra del Fuego, where for generations they have been persecuted by the savages. Both at these islands and at the Galapagos it is particularly noteworthy, as I have shown in my "Journal" by the comparison of the several accounts up to the time when we visited these islands, that the birds are gradually getting less and less tame; and it is surprising, considering the degree of persecution which they have occasionally suf-

vol. ii, p. 246) says that at the C. de Verde Islands the pigeons were so tame as readily to be caught. These, then, are the only large groups of islands, with the exception of the oceanic (of which I can find no early account) which were uninhabited when discovered. Thos. Herbert in 1626 in his *Travels* (p. 349) describes the tameness of the birds at Mauritius, and Du Bois in 1669-72 enters into details on this head with respect to all the birds at Bourbon. Capt. Moresby lent me a MS account of his survey of St. Pierre and Providence Islands, north of Madagascar, in which he describes the extreme tameness of the pigeons. Capt. Carmichael has described the tameness of the birds at Tristan d'Acunha.

* Le Roy, *Lettres Philosoph.*, p. 86.

ferred during the last one or two centuries, that they have not become wilder; it shows that the fear of man is not soon acquired.

In old inhabited countries, where the animals have acquired much general and instinctive suspicion and fear, they seem very soon to learn from each other, and perhaps even from other species, caution directed towards any particular object. It is notorious that rats and mice cannot long be caught by the same sort of trap,* however tempting the bait may be; yet, as it is rare that one which has actually been caught escapes, the others must have learnt the danger from seeing their companions suffer. Even the most terrific object, if never causing danger, and if not *instinctively* dreaded, is immediately viewed with indifference, as we see in our railway trains. What bird is so difficult to approach as the heron, and how many generations would it not require to make herons fearless of man? Yet Mr. Thompson says† that these birds, after a few days' experience, would fearlessly allow a train to pass within half gun-shot distance.‡ Although it cannot be doubted that the fear of man in old inhabited countries is partly acquired, yet it also certainly is instinctive; for nesting birds are generally terrified at the first sight of man, and certainly far more so than most of the old birds at the Falklands and Galapagos Archipelago after years of persecution.

We have in England excellent evidence of the fear of man being acquired and inherited in proportion to the danger incurred; for, as was long ago remarked by the Hon. Daines Barrington,§ all our *large* birds, young and old, are extremely wild. Yet there can be no relation between size and fear;

* E. P. Thompson, *Passions of Animals*, p. 29.

† *Nat. Hist. of Ireland*, "Birds," vol. ii, p. 133.

‡ [I may here refer to the corroboration which this statement has recently received in a correspondence between Dr. Rae and Mr. Goodsir (*Nature*, July 3rd, 12th, and 19th, 1883). The former says that the wild duck, teal, &c., which frequent certain districts through which the Pacific Railway has been carried in Canada, became quite fearless of the trains the first few days after traffic was opened, and the latter gives similar testimony concerning the wild fowl of Australia, adding, "The constant roar of a great passing traffic, as well as the unceasing turmoil and unearthly noises of a large railway station within a stone's throw of their haunts, is now quite unnoticed by these usually most watchful and wary of all birds. [*i.e.*, wild ducks.] But for fear of trespassing on your space, I could give many more illustrations of the truth of Dr. Rae's remarks."—G. J. R.]

§ *Phil. Trans.*, 1773, p. 264.

for on unfrequented islands, when first visited, the large birds were as tame as the small. How exceedingly wary is our magpie; yet it fears not horses or cows, and sometimes alights on their backs, just like the doves at the Galapagos did in 1684 on Cowley. In Norway, where the magpie is not persecuted, it picks up food "close about the doors, sometimes walking inside the houses."* The hooded crow (*C. cornix*), again, is one of our wildest birds; yet in Egypt† is perfectly tame. Every single young magpie and crow cannot have been frightened in England, and yet all are fearful of man in the extreme: on the other hand, in the Falkland and Galapagos Islands many old birds, and their parents before them, must have been frightened and seen others killed; yet they have not acquired a salutary dread of the most destructive animal, man.‡

Animals feigning, as it is said, Death—an unknown state to each living creature—seemed to me a remarkable instinct. I agree with those authors§ who think that there has been much exaggeration on this subject: I do not doubt that fainting (I have had a Robin faint in my hands) and the paralyzing effects of excessive fear have sometimes been mistaken for the simulation of death.|| Insects are most notori-

* Mr. C. Hewitson in *Magazine of Zoology and Botany*, vol. ii, p. 311.

† Geoffry St. Hilaire, *Anns. des Mus.*, tome ix, p. 471.

‡ [I have already pointed out the refined degree to which such instinctive dread of man is developed when it is able accurately to discriminate what constitutes safe distance from fire-arms. Since writing the passage to which I allude (see p. 197), I have met with the following observation in the letters recently published by Dr. Rae in *Nature*, which is of interest as showing how rapidly such refinement of discrimination is attained:—"I may perhaps be permitted to give one of many instances known to me of the quickness of birds in acquiring a knowledge of danger. Golden plover, when coming from their breeding-places in high latitudes, visit the islands north of Scotland in large numbers, and keep together in great packs. At first they are easily approached, but after a very few shots being fired at them, they become not only much more shy, but seem to measure with great accuracy the distance at which they are safe from harm."—G. J. R.]

§ Couch, *Illustrations of Instinct*, p. 201.

|| The most curious case of apparently true simulation of death is that given by Wrangel (*Travels in Siberia*, p. 312, Eng. trans.) of the geese which migrate to the Tundras to moult, and are then quite incapable of flight. He says they feigned death so well "with their legs and necks stretched out quite stiff, that I passed them by, thinking they were dead." But the natives were not thus taken in. This simulation would not save them from foxes or wolves, &c., which I presume inhabit the Tundras: would it save them from hawks? The case seems a strange one. A lizard in Patagonia (*Journal of Researches*, p. 97), which lives on the sand near the coast, and is speckled like it, when frightened feigned death with outstretched legs, depressed body,

ous in this respect. We have amongst them a most perfect series, even within the same genus (as I have observed in *Curculio* and *Chrysomela*), from species which feign only for a second and sometimes imperfectly, still moving their antennæ (as with some *Histers*), and which will not feign a second time however much irritated, to other species which, according to De Geer, may be cruelly roasted at a slow fire, without the slightest movement—to others, again, which will long remain motionless as much as twenty-three minutes, as I find with *Chrysomela spartii*. Some individuals of the same species of *Ptinus* assumed a different position from that of others. Now it will not be disputed that the manner and duration of the feint is useful to each species, according to the kind of danger which it has to escape; therefore there is no more real difficulty in its acquirement, through natural selection, of this hereditary attitude than of any other. Nevertheless, it struck me as a strange coincidence that the insects should thus have come to exactly simulate the state which they took when dead. Hence I carefully noted the simulated positions of seventeen different kinds of insects (including an *Iulus*, Spider, and *Oniscus*) belonging to the most distinct genera, both poor and first-rate shamblers; afterwards I procured naturally dead specimens of some of these insects, others I killed with camphor by an easy slow death; the result was that in no one instance was the attitude exactly the same, and in several instances the attitude of the feigners and of the really dead were as unlike as they possibly could be.

Nidification and Habitation.—We come now to more complex instincts. The nests of Birds have been carefully attended to, at least in Europe and the United States; so that we have a good and rare opportunity of seeing whether there is any variation in an important instinct, and we shall find that this is the case. We shall further find that favourable opportunities and intelligence sometimes slightly modify the constructive instinct. In the nests of birds, also, we have an unusually perfect series, from those which build none, but lay on the bare ground, to others which make a most imperfect and simple nest, to others more perfect, and and closed eyes; if further disturbed, it buried itself quickly in the sand. If the Hare had been a small insignificant animal, and if she had closed her eyes when on her form, should we not perhaps have said that she was feigning death? In regard to Insects, see Kirby and Spence, *Introduction to Entomology*, vol. ii, p. 234.

so on, till we arrive at marvellous structures, rivalling the weavers' art.

Even in so singular a nest as that of the *Hirundo* (*Collocalia esculenta*), eaten by the Chinese, we can, I think, trace the stages by which the necessary instinct has been acquired. The nest is composed of a brittle white translucent substance, very like pure gum arabic, or even glass, lined with adherent feather-down. The nest of an allied species in the British Museum consists of irregularly reticulated fibres, some as fine as * of the same substance; in another species bits of sea-weed are agglutinated together with a similar substance. This dry mucilaginous matter soon absorbs water and softens: examined under the microscope it exhibits no structure, except traces of lamination, and very generally pear-shaped bubbles of various sizes; these, indeed, are very conspicuous in small dry fragments, and some bits looked almost like vesicular lava. A small pure piece put into flame crackles, swells, does not readily burn, and smells strongly of animal matter. The genus *Collocalia*, according to Mr. G. R. Gray, to whom I am much obliged for allowing me to examine all the specimens in the British Museum, ranks in the same sub-family with our common Swift. The latter bird generally seizes on the nest of a sparrow, but Mr. Macgillivray has carefully described two nests in which the confusedly fitted materials were agglutinated together by extremely thin shreds of a substance which crackles but does not readily burn when put into a flame. In N. America† another species of Swift causes its nest to adhere against the vertical wall of a chimney, and builds it of small sticks placed parallel and agglutinated together

* [In the MS a blank is here intentionally left for the subsequent filling in of an appropriate word.—G. J. R.]

† For *Cypselus murarius* see Macgillivray, *British Birds*, vol. iii, 1840, p. 625. For *C. pelagius*, see Mr. Peabody's excellent paper on the Birds of Massachusetts in the *Boston Journal of Nat. Hist.*, vol. iii, p. 187. M. E. Robert (*Comptes Rendus*, quoted in *Ann. and Mag. of Nat. Hist.*, vol. viii, 1842, p. 476) found that the nests of the *Hirundo riparia*, made in the gravelly banks of the Volga, had their upper surfaces plastered with a yellow animal substance, which he imagined to be fishes' spawn. Could he have mistaken the species, for there is no reason to suppose our bank-martin has any such habit? This would be a very remarkable variation of instinct, if it could be proved; and the more remarkable that this bird belongs to a different sub-family from the Swifts and *Collocalia*. Yet I am inclined to believe it, for it has been affirmed with apparent truth that the House-martin moistens the mud, with which it builds its nest, with adhesive saliva.

with cakes of a brittle mucilage which, like that of the esculent swallow, swells and softens in water; in flame it crackles, swells, does not readily burn, and emits a strong animal odour: it differs only in being yellowish-brown, in not having so many large air-bubbles, in being more plainly laminated, and in having even a striated appearance, caused by innumerable elliptical excessively minute points, which I believe to be drawn-out minute air-bubbles.

Most authors believe that the nest of the esculent swallow is formed of either a *Fucus* or of the roe of a fish; others, I believe, have suspected that it is formed of a secretion from the salivary glands of the bird. The latter view I cannot doubt, from the preceding observations, is the correct one. The inland habits of the Swifts and the manner in which the substance behaves in flame almost disposes of the supposition of *Fucus*. Nor can I believe, after having examined the dried roe of fishes, that we should find no trace of cellular matter in the nests, had they been thus formed. How could our Swifts, the habits of which are so well known, obtain roe without being detected? Mr. Macgillivray has shown that the salivary crypts of the Swifts are largely developed, and he believes that the substance with which the materials of its nest are fitted together, is secreted by their glands. I cannot doubt that this is the origin of the similar and more copious substance in the nest of the North American Swift, and in those of the *Collocalia esculenta*. We can thus understand its vesicular and laminated structure, and the curious reticulated structure of the Philippian Island species. The only change required in the instinct of these several birds is that less and less foreign materials should be used. Hence I conclude that the Chinese make soup of dried saliva.*

In looking for a perfect series in the less common forms of birds' nests, we should never forget that all existing birds must be almost infinitely few compared with those which have existed since footprints were impressed on the beach of the New Red Sandstone formation of North America.

If it be admitted that the nest of each bird, wherever placed and however constructed, be good for that species

* [It is almost needless to observe that we must remember the date at which this was written; but it may be remarked that as early as 1817 it was pointed out by Home (*Phil. Trans.*, p. 332) that the proventriculus of *Collocalia* is a peculiar glandular structure probably suited to secrete the substance of which the nest consists.—G. J. R.]

under its own conditions of life; and if the nesting-instinct varies ever so little, when a bird is placed under new conditions, and the variations can be inherited, of which there can be little doubt—then natural selection in the course of ages might modify and perfect almost to any degree the nest of a bird in comparison with that of its progenitors in long past ages. Let me take one of the most extraordinary cases on record, and see how selection may possibly have acted; I refer to Mr. Gould's observation* on the Australian Megapodidæ. The *Talegalla lathamii* scrapes together a great pyramid, from two to four cart-loads in amount, of decaying vegetable matter; and in the middle it deposit its eggs. The eggs are hatched by the fermenting mass, the heat of which was estimated at 90° F., and the young birds scratch their way out of the mound. The accumulation propensity is so strong that a single unmated cock confined in Sydney annually collected an immense mass of vegetable matter. The *Leipoa ocellata* makes a pile forty-five feet in circumference and four feet in height, of leaves thickly covered with sand, and in the same way leaves its eggs to be hatched by the heat of fermentation. The *Megapodius tumulus* in the northern parts of Australia makes even a much larger mound, but apparently including less vegetable matter; and other species in the Malayan Archipelago are said to place their eggs in holes in the ground, where they are hatched by the heat of the sun alone. It is not so surprising that these birds should have lost the instinct of incubation, when the proper temperature is supplied either from fermentation or the sun, as that they should have been led to pile up beforehand a great heap of vegetable matter in order that it might ferment; for, however the fact may be explained, it is known that other birds will leave their eggs when the heat is sufficient for incubation, as in the case of the Fly-catcher which built its nest in Mr. Knight's hot-house.† Even the snake takes advantage of a hot-bed in which to lay its eggs; and what concerns us more, is that a common hen, according to Professor Fischer, "made use of the artificial heat of a hot-bed to hatch her eggs."‡ Again Réaumur, as well as Bonnet,

* *Birds of Australia*, and *Introduction to the Birds of Australia*, 1848, p. 82.

† *Yarrel's British Birds*, vol. i, p. 166.

‡ Alison, article "Instinct" in *Todd's Cyclop. of Anat. and Physiol.*, p. 21.

observed* that ants ceased their laborious task of daily moving their eggs to and from the surface according to the heat of the sun, when they had built their nest between the two cases of a bee-hive, where a proper and equable temperature was provided.

Now let us suppose that the conditions of life favoured the extension of a bird of this Family, whose eggs were hatched by the solar rays alone, into a cooler, damper, and more wooded country: then those individuals which chanced to have the accumulative propensity so far modified as to prefer more leaves and less sand, would be favoured in their extension; for they would accumulate more vegetable matter, and its fermentation would compensate for the loss of solar heat, and thus more young birds would be hatched which might as readily inherit the peculiar accumulative propensity of their parents as our breeds of dogs inherit a tendency to retrieve, another to point, and another to dash round its prey. And this process of natural selection might be continued, till the eggs came to be hatched exclusively by the heat of fermentation; the bird, of course, being as ignorant of the cause of the heat as of that of its own body.

In the case of corporeal structures, when two closely allied species, one for instance semi-aquatic and the other terrestrial, are modified for their different manners of life, their main and general agreement of structure is due, according to our theory, to descent from common parents; and their slight differences to subsequent modification through natural selection. So when we hear that the thrush of South America (*T. Falklandicus*), like our European species, lines her nest in the same peculiar way with mud, though, from being surrounded by wholly different plants and animals, she must be placed under somewhat different conditions; or when we hear that in North America the males of the kitty wrens,† like the male of our species, have the strange and anomalous habit of making "cock-nests," not lined with feathers, in which to shelter themselves;—when we hear of such cases, and they are sufficiently numerous in all classes of animals, we must attribute the similarity of the instinct to inheritance from common progenitors, and the dissimilarity, either to

* Kirby and Spence, *Introd. to Entomol.*, vol. ii, p. 519.

† Peabody in *Boston Journ. Nat. Hist.*, vol. iii, p. 144. For our British species see Macgillivray, *Brit. Birds*, vol. iii, p. 23.

selected and profitable modification, or to acquired and inherited habit. In the same manner, as the northern and southern thrushes have largely inherited their instinctive modification from a common parent, so no doubt the thrush and blackbird have likewise inherited much from their common progenitor, but with somewhat more considerable modifications of instinct in one or both species, from that of their ancient and unknown ancestor.

We will now consider the variability of the nesting-instinct. The cases, no doubt, would have been far more numerous, had the subject been attended to in other countries with the same care as in Great Britain and the United States. From the general uniformity of the nests of each species, we clearly see that even trifling details, such as the materials used and the situation chosen on a high or low branch, on a bank or on level ground, whether solitary or in communities, are not due to chance, or to intelligence, but to instinct. The *Sylvia sylvicola*, for instance, can be distinguished from two closely allied wrens more readily by its nest being lined with feathers than by almost any other character. ("Yarrell's British Birds.")

Necessity or compulsion often leads birds to change the situation of their nests: numerous instances could be given in various parts of the world of birds breeding in trees, but in treeless countries on the ground, or amongst rocks. Audubon (quoted in "Boston Journ. Nat. Hist.," vol. iv, p. 249) states that the Gulls on an islet off Labrador, "in consequence of the persecution which they have met with, now build in trees," instead of in the rocks. Mr. Couch ("Illustrations of Instinct," p. 218) states that three or four successive layings of the sparrow (*F. domesticus*) having been destroyed, "the whole colony, as if by mutual agreement, quitted the place and settled themselves amongst some trees at a distance—a situation which, though common in some districts, neither they nor their ancestors had ever before occupied here, where their nests became objects of curiosity." The sparrow builds in holes in walls, on high branches, in ivy, under rooks' nests, in the holes made by the sand-martins, and often seizes on the nest made by the house-martin: "the nest also varies greatly according to the place" (Montague, "Ornitho. Dict.," p. 482). The Heron (Macgillivray, "Brit. Birds," vol. iv, p. 446: W. Thompson, "Nat. Hist. Ireland," vol. ii, p. 146) builds in trees, on precipitous sea-cliffs, and amongst heath on the ground. In the United States the *Ardea herodias* (Peabody in "Boston Journal Nat. Hist.," vol. iii, p. 209) likewise builds in tall or low trees, or on the ground; and, which is more remarkable, sometimes in communities or heronries, and sometimes solitarily.

Convenience comes into play: we have seen that the Taylor-bird in India uses artificial thread instead of weaving it. A wild Gold-finch (Bolton's *Harmonia Ruralis*, vol. i, p. 492) first took wool, then cotton, and then down, which was placed near its nest. The common Robin will often build under sheds, four cases having been observed in one season at one place (W. Thompson, "Nat. Hist. Ireland," vol. i, p. 14). In Wales the Martin (*H. urbica*) builds against perpendicular cliffs, but all over the lowlands of England against houses; and this must have prodigiously increased its range and numbers. In Arctic America in 1825 *Hirundo lunifrons* (Richardson, "Fauna Boreali-Americani," p. 331) for the first time built against houses; and the nests, instead of being clustered and each having a tubular entrance, were built under the eaves in a single line and without the

tubular entrance, or with a mere ledge. The date of a similar change in the habits of *H. fulva* is also known.

In all changes, whether from persecution or convenience, intelligence must come into play in some degree. The Kitty-wren (*T. vulgaris*), which builds in various situations, usually makes its nest to match with surrounding objects (Macgillivray, vol. iii, p. 21); but this perhaps is instinct. Yet when we hear from White (Letter 14) that a Willow-wren (and I have known a similar case), having been disturbed by being watched, concealed the orifice of her nest, we might argue that the case was one of intelligence. Neither the Kitty-wren nor Water-ouzel ("Mag. of Zool.," vol. ii, 1838, p. 429), invariably build domes to their nests, when placed in sheltered situations. Jesse describes a Jackdaw which built its nest on an inclined surface in a turret, and reared up a perpendicular stack of sticks ten feet in height—a labour of seventeen days: families of this bird, I may add (White's "Selborne," Letter 21), have been known regularly to build in rabbit-burrows. Numerous analogous facts could be given. The Water-hen (*G. chloropus*) is said occasionally to cover her eggs when she leaves her nest, but in one protected place W. Thompson ("Nat. Hist. Ireland," vol. ii, p. 328) says that this was never done. Water-hens and Swans, which build in or near the water, will instinctively raise their nest as soon as they perceive the water begin to rise (Couch "Illustrations of Instinct," p. 223-6). But the following seems a more curious case:—Mr. Yarrell showed me a sketch of the nest of a Black Australian Swan, which had been built directly under the drip of the eaves of a building; and, to avoid this, male and female conjointly added semicircular * to the nest, until it extended close to the wall, within the line of drip; and then they pushed the eggs into the newly added portion, so as to be quite dry. The Magpie (*Corvus pica*) under ordinary circumstances builds a remarkable, but very uniform nest; in Norway they build in churches, or spouts under the eaves of houses, as well as in trees. In a treeless part of Scotland, a pair built for several years in a gooseberry bush, which they barricaded all round in an extraordinary manner with briars and thorns, so that "it would have cost a fox some days' labour to have got in." On the other hand, in a part of Ireland, where a reward had been offered for each egg and the magpies had been much persecuted, a pair built at the bottom of a low thick hedge, "without any large collection of materials likely to attract notice." In Cornwall, Mr. Couch says he has seen near each other, two nests, one in a hedge not a yard from the ground and "unusually fenced in with a thick structure of thorns;" the other "on the top of a very slender and solitary elm—the expectation clearly being that no creature would venture to climb so fragile a column." I have been struck by the slenderness of the trees sometimes chosen by the magpie; but, intelligent as this bird is, I cannot believe that it foresees that boys could not climb such trees, but rather that, having chosen such a tree, it has found from *experience* that it is a safe place.†

Although I do not doubt that intelligence and experience often come into play in the nidification of Birds, yet both often fail: a Jackdaw has been seen trying in vain to get a stick through a turret window, and had

* [A word is here accidentally omitted in the MS.—G. J. R.]

† For Norway, see in *Mag. of Zool. and Bot.*, 1838, vol. ii, p. 311. For Scotland, Rev. J. Hall, *Travels in Scotland*, see Art. "Instinct" in *Cyclop. of Anat. and Physiol.*, p. 22. For Ireland, W. Thompson, *Nat. Hist. of Ireland*, vol. ii, p. 329. For Cornwall, see Couch, *Illustrations of Instinct*, p. 213.

not sense to draw it in lengthways: White (Letter 6) describes some martins which year after year built their nests on an exposed wall, and year after year they were washed down. The *Furnarius cunicularius* in S. America makes a deep burrow in mud-banks for its nest; and I saw ("Journal of Researches," p. 216) these little birds vainly burrowing numerous holes through mud-walls, over which they were constantly flitting, without thus perceiving that the walls were not nearly thick enough for their nests.

Many variations cannot in any way be accounted for: the *Totanus macularius* (Peabody, "Boston Journ. Nat. Hist.," vol. iii, p. 219) lays her eggs sometimes on the bare ground, sometimes in nests slightly made of grass. Mr. Blackwall has recorded the curious case of a yellow Bunting (*Emberiza citrinella*) given in "Yarrell's British Birds," which laid its eggs and hatched them on the bare ground: this bird generally builds on or very close to the ground, but a case is recorded of its having built at a height of seven feet. A nest of a Chaffinch (*Fringilla cœlebs*; "Annals and Mag. of Nat. History," vol. viii, 1842, p. 281) has been described, which was bound by a piece of whipcord passing once round a branch of a pine tree, and then firmly interwoven with the materials of the nest: the nest of the chaffinch can almost be recognized by the elegant manner with which it is coated with lichen; but Mr. Hewitson ("British Oology," p. 7) has described one in which bits of paper were used for lichen. The Thrush (*T. musicus*) builds in bushes, but sometimes, when bushes abound, in holes of walls or under sheds; and two cases are known of its having built actually on the ground in long grass and under turnip-leaves (W. Thompson, "Nat. Hist. of Ireland," vol. i, p. 136: Couch, "Illustrations of Instinct," p. 219). The Rev. W. D. Fox informs me that an "eccentric pair of blackbirds" (*T. merula*) for three consecutive years built in ivy against a wall, and always lined their nest with black horse-hair, though there was nothing to tempt them to use this material: the eggs also were not spotted. The same excellent observer has described (in "Hewitson's British Oology") the nests of two Redstarts, of which one alone was lined with a profusion of white feathers. The Golden-crested Wren (Mr. Sheppard in "Linn. Trans.," vol. xv, p. 14) usually builds an open nest attached to the under side of a fir-branch, but sometimes on the branch, and Mr. Sheppard has seen one "pendulous with a hole on one side." Of the wonderful nest of the Indian Weaver-bird (*Ploceus Philippensis*, "Proc. Zool. Soc.," July 27, 1852), about one or two in every fifty have an upper chamber, in which the males nest, grooved by the widening of the stem of the nest with a pent-house added to it. I will conclude by adding two general remarks on this head by two good observers (Sheppard in "Linn. Trans.," vol. xv, p. 14, and Blackwall quoted by Yarrell, "British Birds," vol. i, p. 444). "There are few birds which do not occasionally vary from the general form in building their nests." "It is evident," says Mr. Blackwall, "that birds of the same species possess the constructive powers in very different degrees of perfection, for the nests of some individuals are finished in a manner greatly superior to those of others."

Some of the cases above given, such as the *Totanus* either making a nest or building on the bare ground, or that of the Water-ouzel making or not making a dome to its nest, ought, perhaps, to be called a double instinct rather than a variation. But the most curious case of a double instinct which I have met with, is that of the *Sylvia cisticola* given by Dr. P. Savi ("Anns. des Sc. Nat.," tome ii, p. 126). This bird in Pisa annually makes two nests; the autumnal nest is formed by leaves being sewn together with spiders' webs and the down of plants, and is placed in marshes; the vernal nest is placed in tufts of grass in corn-fields, and the leaves are not sewn together; but the

sides are thicker and very different materials are used. In such cases, as was formerly remarked with respect to corporeal structures, a great and *apparently* abrupt change might be effected in the instinct of a bird by one form alone of the nest being retained.

In some cases, when the same species ranges into a different climate, the nest differs; the *Artamus sordidus* in Tasmania builds a larger, more compact, and neater nest, than in Australia (Gould's "Birds of Australia"). The *Sterna minuta*, according to Audubon ("Anns. of Nat. Hist.," vol. ii, 1839, p. 462), in the southern and middle U. States merely scoops a slight hollow in the sand; "but on the coast of Labrador it makes a very snug nest, formed of dry moss, well matted together and nearly as large as that of the *Turdus migratorius*." Those individuals of *Icterus Baltimore* (Peabody in "Boston Journ. of Nat. Hist.," vol. iii, p. 97) "which build in the south make their nests of light moss, which allows the air to pass through, and complete it without lining; while in the cool climate of New England they make their nests of soft substances closely woven with a warm lining."

Habitations of Mammals.—On this head I shall make but few remarks, having said so much on the nests of Birds. The buildings erected by the Beaver have long been celebrated; but we see one step by which its wonderful instincts might have been perfected, in the simpler house of an allied animal, the Musk Rat (*Fiber zibethicus*) which, however, Hearne* says is something like that of the Beaver. The solitary Beavers of Europe do not practise, or have lost the greater part of their constructive instincts. Certain species of Rats now uniformly inhabit the roofs of houses,† but other species keep to hollow trees—a change analogous to that in swallows. Dr. Andrew Smith informs me that in the uninhabited parts of S. Africa the hyænas do not live in burrows, whilst in the inhabited and disturbed parts they do.‡ Several mammals and birds usually inhabit burrows made by other species, but when such do not exist, they excavate their own habitations.§

In the genus *Osmia*, one of the Bee family, the several species not only offer the most remarkable differences, as described by Mr. F. Smith|| in their instincts; but the individuals of the same species vary to an unusual degree in this respect; thus illustrating the rule, which certainly seems to

* *Hearne's Travels*, p. 380. Hearne has given the best description (pp. 227–236) ever published of the habits of the Beaver.

† Rev. L. Jenyns in *Linn. Trans.*, vol. xvi, p. 166.

‡ A case sometimes quoted of Hares having made burrows in an exposed situation (*Anns. of Nat. Hist.*, vol. v, p. 362), seems to me to require verification: were not the old rabbit-burrows used?

§ *Zoology of the Voyage of the Beagle*, "Mammalia," p. 90.

|| *Catalogue of British Hymenoptera*, 1855, p. 158.

hold in corporeal structures, namely, that the parts which differ most in allied species, are apt also to vary most in the same species. Another Bee, the *Megachile maritima*, as I am informed by Mr. Smith, near the sea makes its burrows in the sand-banks, whilst in wooded districts it bores holes in posts.*

I have now discussed several of the most extraordinary classes of instincts; but I have still a few miscellaneous remarks which seem to me worth making. First for a few cases of variation which have struck me: a spider which had been crippled and could not spin its web, changed its habits from compulsion into hunting—which is the regular habit of one large group of spiders.† Some insects have two very different instincts under different circumstances, or at different times of life; and one of the two might through natural selection be retained, and so cause an apparently abrupt difference in instinct in relation to the insects' nearest allies: thus the larva of a beetle (the *Cionus scrophulariæ*), when bred on the scrophularia, exudes a viscid substance, which makes a transparent bladder, within which it undergoes its metamorphosis; but the larva when naturally bred, or transported by man, on to a verbascum, becomes a burrower, and undergoes its metamorphosis within a leaf.‡ In the caterpillars of certain moths there are two great classes, those which burrow in the parenchyma of leaves, and those which roll up leaves with consummate skill: some few caterpillars in their early age are burrowers, and then become leaf-rollers; and this change was justly considered so great, that it was only lately discovered that the caterpillars belonged to the same species.§ The Angoumois moth usually has two broods: the first are hatched in the spring from eggs laid in the autumn on grains of corn stored in granaries, and then immediately take flight to the fields and lay their eggs on the standing corn, instead of on the naked grains stored all round them: the moths of the second brood (produced from the eggs laid on the standing corn) are hatched in the granaries, and then do not leave the granaries, but deposit their eggs on the grains around them; and from these eggs proceed the vernal brood which have the

* [Here follows a section on the instincts of Parasitism, Slave-making, and Cell-making, which is published in the *Origin of Species*.—G. J. R.]

† Quoted on authority of Sir J. Banks in *Journal Linn. Soc.*

‡ P. Huber in *Mém. Soc. Phys. de Genève*, tome x, p. 33.

§ Westwood, in *Gardeners' Chronicle*, 1852, p. 261.

different instinct of laying on the standing corn.* Some hunting spiders, when they have eggs and young, give up hunting and spin a web wherewith to catch prey: this is the case with a *Salticus*, which lays its eggs within snail-shells, and at that time spins a large vertical web.† The pupæ of a species of *Formica* are *sometimes*‡ uncovered, or not enclosed within cocoons; this certainly is a highly remarkable variation; the same thing is said to occur with the common *Pulex*. Lord Brougham§ gives us a remarkable case of instinct, namely, the chicken within the shell pecking a hole and then “chipping with its bill-scale till it has cut off a segment from the shell. It always moves from right to left, and it always cuts off the segment from the big end.” But the instinct is not quite so invariable, for I was assured at the Eccalobeion (May, 1840) that cases have occurred of chickens having commenced so close to the broad end, that they could not escape from the hole thus made, and had consequently to commence chipping again so as to remove another and larger rim of shell: moreover occasionally they have begun at the narrow end of the shell. The fact of the occasional regurgitation of its food by the Kangaroo|| ought, perhaps, to be considered as due to an intermediate or variable modification of structure, rather than of instinct; but it is worth notice. It is notorious that the same species of Bird has slightly different vocal powers in different districts; and an excellent observer remarks that “an Irish covey of Partridges springs without uttering a call, whilst on the opposite coast the Scotch covey shrieks with all its might when sprung.”¶ Bechstein says that from many years’ experience he is certain that in the nightingale a tendency to sing in the middle of the night or in the day runs in families and is strictly inherited.** It is remarkable that many birds have the capacity of piping long and difficult tunes, and others, as the Magpie, of imitating

* Bonnet, quoted by Kirby and Spence, *Entomology*, vol. ii, p. 480.

† Dugès in *Ann. des Sci. Nat.*, 2nd series, tome vi, p. 196.

‡ F. Smith in *Trans. Ent. Soc.*, vol. iii, N.S., Pt. iii, p. 97; and De Geer, quoted by Kirby and Spence, *Entomology*, vol. iii, p. 227.

§ *Dissertation on Natural Theology*, vol. i, p. 117.

|| W. C. Martin in *Mag. of Nat. Hist.*, N.S., vol. ii, p. 323.

¶ W. Thompson, in *Nat. Hist. Ireland*, vol. ii, p. 65, says that he has observed this, and that it is well known to sportsmen.

** *Stuben-vögel*, 1840, s. 323. See on different powers of singing in different places, s. 205 and 265.

all sorts of sounds, and yet that in a state of nature they never display these powers.*

As there is often much difficulty in imagining how an instinct could first have arisen, it may be worth while to give a few, out of many cases, of occasional and curious habits, which cannot be considered as regular instincts, but which might, according to our views, give rise to such. Thus, several cases are on record† of insects which naturally have very different habits having been hatched within the bodies of men—a most remarkable fact considering the temperature to which they have been exposed, and which may explain the origin of the instinct of the Gad-fly or *Æstrus*. We can see how the closest association might be developed in Swallows, for Lamarck‡ saw a dozen of these birds aiding a pair, whose nest had been taken, so effectually that it was completed on the second day; and from the facts given by Macgillivray§ it is impossible to doubt that the ancient accounts are true of the Martins sometimes associating and entombing alive sparrows which have taken possession of one of their nests. It is well known that the Hive-bees which have been neglected “get a habit of pillaging from their more industrious neighbours,” and are then called corsairs; and Huber gives a far more remarkable case of some Hive-bees which took almost entire possession of the nest of a Humble-bee, and for three weeks the latter went on collecting honey and then regorged it at the solicitation, without any violence, of the Humble-bee.|| We are thus reminded of those Gulls (*Lestris*) which exclusively live by pursuing other gulls and compelling them to disgorge their food.¶

In the Hive-bee actions are occasionally performed which

* Blackwall's *Researches in Zoology*, 1834, p. 158. Cuvier long ago remarked that all the passerines have apparently a similar structure in their vocal organs; and yet only a few, and these the males, sing; showing that fitting structure does not always give rise to corresponding habits. [Concerning birds which imitate sounds when in captivity not doing so in a state of nature, see p. 222, where there is evidence of certain wild birds imitating the sounds of other species.—G. J. R.]

† Rev. L. Jenyns, *Observations in Nat. Hist.*, 1846, p. 280.

‡ Quoted by Geoffroy St. Hilaire in *Ann. des Mus.*, tome ix, p. 471.

§ *British Birds*, vol. iii, p. 591.

|| Kirby and Spence, *Entomology*, vol. ii, p. 207. The case given by Huber is at p. 119.

¶ There is reason to suspect (Macgillivray, *British Birds*, vol. v, p. 500) that some of the species can only digest food which has been partially digested by other birds.

we must rank amongst the most wonderful of instincts ; and yet these instincts must often have been dormant during many generations : I refer to the death of the queen, when several worker-larvæ are necessarily destroyed, and being placed in large cells and reared on royal food, are thus rendered fertile : so again when a hive has its queen, the males are all infallibly killed by the workers in autumn ; but if the hive has no queen, not a single drone is ever destroyed.* Perhaps a ray of light is thrown by our theory on these mysterious but well ascertained facts, by considering that the analogy of other members of the Bee family would lead us to believe that the Hive-bee is descended from other Bees which regularly had many females inhabiting the same nest during the whole season, and which never destroyed their own males ; so that not to destroy the males and to give the normal food to additional larvæ, perhaps is only a reversion to an ancestral instinct, and, as in the case of corporeal structures reverting, is apt to occur after many generations.†

I will now refer to a few cases of special difficulty on our theory—most of them parallel to those which I adduced when discussing in Chapter VIII corporeal structures. Thus we occasionally meet with the same peculiar instinct in animals widely remote in the scale of nature, and which consequently cannot have derived the peculiarity from community of descent. The *Molothrus* (a bird something like a starling) of N. and S. America has precisely the same habits with the Cuckoo ; but parasitism is so common throughout nature that this coincidence is not very surprising. The parallelism in instinct between the White Ants, belonging to the Neuroptera, and ants belonging to the Hymenoptera, is a far more wonderful fact ; but the parallelism seems to be very far from close. Perhaps as remarkable a case as any on record of the same instinct having been independently acquired in two animals very remote from each other in relationship, is that of a Neuropterous and a Dipterous larva digging a conical

* Kirby and Spence, *Entomology*, vol. ii, pp. 510-13.

† [Concerning the question why there are so many drones as to require killing, see *Animal Intelligence*, p. 166, where I suggest that among the ancestors of the Hive-bee the males may have been of use as workers. But possibly the drones may even now be of use as nurses to the larvæ, for I am told by an experienced bee-keeper that he believes this to be the case.—G. J. R.]

pit-fall in loose sand, lying motionless at the bottom, and if the prey is about to escape, casting jets of sand all round.*

It has been asserted that animals are endowed with instincts, not for their own individual good, or for that of their own social bodies, but for the good of other species, though leading to their own destruction: it has been said that fishes migrate that birds and other animals may prey on them: † this is impossible on our theory of natural selection of self-profitable modification of instinct. But I have met with no facts in support of this belief worthy of consideration. Mistakes of instinct, as we shall presently see, may in some cases do injury to a species and profit another; one species may be compelled, or even apparently induced by persuasion, to yield up its food or secretion to another species; but that any animal has been specially endowed with an instinct leading to its own destruction or harm, I cannot believe without better evidence than has hitherto been adduced.

An instinct performed only once during the life of an animal appears at first sight a great difficulty on our theory; but if indispensable to the animal's existence, there is no valid reason why it should not have been acquired through natural selection, like corporeal structures used only on one occasion, like the hard tip to the chicken's beak, or like the temporary jaws of the pupa of the Caddis-fly or Phryganea, which are exclusively used for cutting open the silken doors of its curious case, and which are then thrown off for ever. ‡ Nevertheless it is impossible not to feel unbounded astonishment, when one reads of such cases as that of a caterpillar first suspending itself by its tail to a little hillock of silk attached to some object, and then undergoing its metamorphosis; then after a time splitting open one side and exposing the pupa, destitute of limbs or organs of sense and lying loose within the *lower* part of the old bag-like split skin of the caterpillar: this skin serves as a ladder which the pupa ascends by seizing on portions between the creases of its abdominal segments, and then searching with its tail, which is provided with little hooks, thus attaches itself, and

* Kirby and Spence, *Entomology*, vol. i, pp. 429-435.

† Linnæus in *Amœnitates Academicæ*, vol. ii; and Prof. Alison on "Instinct" in *Todd's Cycl. of Anat. and Physiol.*, p. 15.

‡ Kirby and Spence, *Entomology*, vol. iii, p. 287.

afterwards disengages and casts off the skin which had served it for a ladder.* I am tempted to give one other analogous case, that of the caterpillar of a Butterfly (*Thekla*), which feeds within the pomegranate, but when full fed gnaws its way out (thus making the exit of the butterfly possible before its wings are fully expanded), and then attaches with silk threads the point to the branch of the tree, that it may not fall before the metamorphosis is complete. Hence, as in so many other cases, the larva works on this occasion for the safety of the pupa and of the mature insect. Our astonishment at this manœuvre is lessened in a very slight degree when we hear that several caterpillars attach more or less perfectly with silken threads leaves to the stems for their own safety; and that another caterpillar, before changing into a pupa, bends the edges of a leaf together, coats one surface with a silk web, and attaches this web to the footstalk and branch of the tree; the leaf afterwards becomes brittle and separates, leaving the silken cocoon attached to the footstalk and branch; in this case the process differs but little from the ordinary formation of a cocoon and its attachment to any object.†

A really far greater difficulty is offered by those cases in which the instincts of a species differ greatly from those of its related forms. This is the case with the above mentioned *Thekla* of the pomegranate; and no doubt many instances could be collected. But we should never forget what a small proportion the living must bear to the extinct amongst insects, the several orders of which have so long existed on this earth. Moreover, just in the same way as with corporeal structures, I have been surprised how often when I thought I had got a case of a perfectly isolated instinct, I found on further enquiry at least some traces of a graduated series.

I have not rarely felt that small and trifling instincts were a greater difficulty on our theory than those which have so justly excited the wonder of mankind; for an instinct, if really of no considerable importance in the struggle for life, could not be modified or formed through natural selection. Perhaps as striking an instance as can be given is that of the worker of the Hive-bee arranged in files and ventilating, by a peculiar movement of their wings, the

* Kirby and Spence, *Entomology*, vol. iii, pp. 208-11.

† J. O. Westwood in *Trans. Entomol. Soc.*, vol. ii, p. 1.

well-closed hive: this ventilation has been artificially imitated,* and as it is carried on even during winter, there can be no doubt that it is to bring in free air and displace the carbonic acid gas: therefore it is in truth indispensable, and we may imagine the stages—a few bees first going to the orifice to fan themselves—by which the instinct might have been arrived at. We admire the instinctive caution of the hen-pheasant which leads her, as Waterton remarked, to fly from her nest and so leave no track to be scented out by beasts of prey; but this again may well be of high importance to the species. It is more surprising that instinct should lead small nesting birds to remove their broken eggs and the early mutings, whereas with partridges, the young of which immediately follow their parents, the broken eggs are left round the nest; but when we hear that the nests of those birds (*Halcyonidæ*) in which the mutings are not enclosed by a film, and so can hardly be removed by the parent, are thus “rendered very conspicuous;”† and when we remember how many nests are destroyed by cats, we cannot any longer consider them instincts of trifling importance. But some instincts one can hardly avoid looking at as mere tricks, or sometimes as play: an Abyssinian pigeon when fired at, plunges down so as to almost touch the sportsman, and then mounts to an immoderate height:‡ the Bizcacha (*Lagostomus*) almost invariably collects all sorts of rubbish, bones, stones, dry dung, &c., near its burrow: Guanacoes have the habit of returning (like Flies) to the same spot to drop their excrement, and I saw one heap eight feet in diameter; as this habit is common to all the species of the genus, it must be instinctive, but it is hard to believe that it can be of any use to the animal, though it is to the Peruvians, who use the dried dung for fuel.§ Many analogous facts could probably be collected.

Wonderful and admirable as most instincts are, yet they cannot be considered as absolutely perfect: there is a con-

* Kirby and Spence, *Entomology*, vol. ii, p. 193.

† Blyth in *Mag. of Nat. Hist.*, N.S., vol. ii.

‡ Bruce's *Travels*, vol. v, p. 187.

§ See my *Journal of Researches*, p. 167 for the Guanaco; for the Bizcacha, p. 145. Many odd instincts are connected with the excrement of animals, as with the wild Horse of S. America (see *Azara's Travels*, vol. i, p. 373), with the common House Fly and with Dogs; see on the urinary deposits of the Hyrax, Livingston's *Missionary Travels*, p. 22.

stant struggle going on throughout nature between the instinct of the one to escape its enemy and of the other to secure its prey. If the instinct of the Spider be admirable, that of the Fly which rushes into its toils is so far inferior. Rare and occasional sources of danger are not avoided: if death inevitably ensues, and creatures cannot have learnt by seeing others suffer, it seems that no guardian instinct is acquired: thus the ground within a solfortara in Java is strewn with the carcasses of tigers, birds, and masses of insects killed by the noxious exhalations, with their flesh, hairs, and feathers preserved, but their bones entirely consumed.* Migratory instinct not rarely fails, and the animals, as we have seen, are lost. What ought we to think of the strong impulse which leads Lemmings, Squirrels, Ermines,† and many other animals which are not regularly migratory, occasionally to congregate and pursue a headlong course, across great rivers, lakes, and even into the sea, where vast numbers perish; and ultimately it would appear that all perish? The country being overstocked seems to cause the original impulse; but it is doubtful whether in all cases scarcity actually prevails. The whole case is quite inexplicable. Does the same feeling act on these animals which causes men to congregate under distress and fear; and are these occasional migrations, or rather emigrations, a forlorn hope to find a new and better land? The occasional emigrations of insects of many kinds associated together, which, as I have witnessed, must perish by countless myriads in the sea, are still more remarkable, as they belong to families none of which are naturally social or even migratory.‡

* Von Buch, *Descript. Phys. des Iles Canaries*, 1836, p. 423, on the excellent authority of M. Reinwardts.

† L. Lloyd, *Scandinavian Adventure*, 1854, vol. ii, p. 77, gives an excellent account of the migration of Lemmings: when swimming across a lake, if they meet a boat, they crawl up one side and down the opposite side. Great migrations took place in 1789, 1807, 1808, 1813, 1823. Ultimately all seem to perish. See Högström's account in *Swedish Acts*, vol. iv, 1763, of ermines migrating and entering the sea. See Bachman's account in *Mag. of Nat. Hist.*, N.S., vol. iii, 1839, p. 229, of the migration of squirrels; they are bad swimmers and get across great rivers.

‡ Mr. Spence in his Anniversary address to the Entomological Society, 1848, has some excellent remarks on the occasional migration of insects, and shows how inexplicable the case is. See also Kirby and Spence, *Entomology*, vol. ii, p. 12; and Weissenborn in *Mag. of Nat. Hist.*, N.S., 1834, vol. iii, p. 516, for interesting details on a great migration of Libellulæ, generally along the course of rivers.

The social instinct is indispensable to some animals, useful to still more for the ready notice of danger, and apparently only pleasant to some few animals. But one cannot avoid thinking that this instinct is carried in some cases to an injurious excess: the antelopes in S. Africa and the Passenger Pigeons in N. America are followed by hosts of carnivorous beasts and birds, which could hardly be supported in such numbers if their prey were scattered. The Bison of N. America migrates in such vast bodies, that when they come to narrow passes in the river-cliffs, the foremost, according to Lewis and Clarke(?),* are often pushed over the precipice and dashed to pieces. Can we believe when a wounded herbivorous animal returns to its own herd and is then attacked and gored, that this cruel and very common instinct is of any service to the species? It has been remarked† that with Deer, only those which have been much chased with dogs are led by a sense of self-preservation to expel their pursued or wounded companion, who will bring danger on the herd. But the fearless wild elephants will “ungenerously attack one which has escaped into the jungles with the bandages still upon its legs.”‡ And I have seen domestic pigeons attack and badly wound sick or young and fallen birds.

The cock-pheasant crows loudly, as everyone may hear, when going to roost, and is thus betrayed to the poacher.§ The wild Hen of India, as I am informed by Mr. Blyth, chuckles like her domesticated offspring, when she has laid an egg;

* [The note of interrogation is in the MS.—G. J. R.]

† W. Scrope, *Art of Deer Stalking*, p. 23.

‡ Corse, in *Asiatic Researches*, vol. iii, p. 272. This fact is the more strange as an Elephant which had escaped from a pit was seen by many witnesses to stop and assist with his trunk his companion in getting out of the pit (*Athenæum*, 1840, p. 238). Capt. Sullivan, R.N., informs me that he watched for more than half an hour, at the Falkland Islands, a Logger-headed Duck defending a wounded Upland Goose from the repeated attacks of a Carrion Hawk. The upland goose first took to the water, and the duck swam close alongside her, always defending her with its strong beak; when the goose crawled ashore, the duck followed, going round and round her, and when the goose again took to the sea the duck was still vigorously defending her; yet at other times this duck *never* associates with this goose, for their food and place of habitation are utterly different. I very much fear, from what we see of little birds chasing hawks, that it would be more philosophical to attribute this conduct in the duck to hatred of the carrion hawk rather than to benevolence for the goose.

§ Rev. L. Jenyns, *Observations in Natural History*, 1846, p. 100.

and the natives thus discover her nest. In La Plata the *Furnarius* builds a large oven-like nest of mud in as conspicuous a place as possible, on a bare rock, on the top of a post, or cactus-stem; * and in a thickly peopled country, with mischievous boys, would soon be exterminated. The great Butcher-bird conceals its nest very badly, and the male during incubation, and the female after her eggs are hatched, betray the nest by their repeated harsh cries.† So again a kind of Shrew-mouse at the Mauritius continually betrays itself by screaming out as soon as approached. Nor ought we to say that these failures of instinct are unimportant, as principally concerning man alone; for, as we see instinctive wildness directed towards man, there seems no reason why other instincts should not be related to him.

The number of eggs of the American Ostrich scattered over the country, and so wasted, has already been noticed. The Cuckoo sometimes lays two eggs in the same nest, leading to the sure rejection of one of the two young birds. Flies, it has often been asserted, frequently make mistakes, and lay their eggs in substances not fitted for the nourishment of their larvæ. A Spider‡ will eagerly seize a little ball of cotton when deprived of her eggs, embedded as they are in a silken envelope; but if a choice be given her, she will prefer her own eggs, and will not always seize the ball of cotton a second time: so that we see sense or reason here correcting a first mistake. Little birds often gratify their hatred by pursuing a Hawk, and perhaps by so doing distract its attention; but they often mistake and persecute (as I have seen) any innocent and foreign species. Foxes and other carnivorous beasts often destroy far more prey than they can devour or carry away: the Bee Cuckoo kills a vast number more bees than she can eat, and “unwisely pursues without interruption this pastime all the day long.”§ A queen Hive-bee confined by Huber, so that she could not lay her eggs in worker cells, would not deposit, but dropped them, upon which the workers devoured them. An unfertilized queen can lay only male eggs, but these she deposits in worker and royal cells—an aberration of instinct not surprising under the circum-

* *Journal of Researches*, p. 95.

† Knapp, *Journal of a Naturalist*, p. 188.

‡ These facts are given by Dugès in *Ann. des Sc. Nat.*, 2nd series, tome vi, p. 196.

§ *Bruce's Travels in Abyssinia*, vol. v, p. 179.

stances ; but "the workers themselves act as if they suffered in their instinct from the imperfect state of their queen, for they fed these male larvæ with royal jelly and treat them as they would a real queen."* But what is more surprising, the workers of Humble-bees habitually endeavour to seize and devour the eggs of their own queens ; and the utmost activity of the mothers is "scarcely adequate to prevent this violence."† Can this strange instinctive habit be of any service to the Bee ? Seeing the innumerable and admirable instincts all directed to rear and multiply young, can we believe, with Kirby and Spence, that this strange aberrant instinct is given them "to keep the population within due bounds ?" Can the instinct which leads the female spider savagely to attack and devour the male after pairing with him‡ be of service to the species ? The carcase of her husband no doubt nourishes her ; and without some better explanation can be given, we are thus reduced to the grossest utilitarianism, compatible, it must be confessed, with the theory of natural selection. I fear that to the foregoing cases a long catalogue could be added.

Conclusion.—We have in this chapter chiefly considered the instincts of animals under the point of view whether it is possible that they could have been acquired through the means indicated on our theory, or whether, even if the simpler ones could have been thus acquired, others are so complex and wonderful that they must have been specially endowed, and thus overthrow the theory. Bearing in mind the facts given on the acquirement, through the selection of self-originating tricks or modification of instinct, or through training and habit, aided in some slight degree by imitation, of hereditary actions and dispositions in our domesticated animals ; and their parallelism (subject to having less time) to the instincts of animals in a state of nature : bearing in mind that in a state of nature instincts do certainly vary in some slight degree : bearing in mind how very generally we find in allied but distinct animals a gradation in the more complex instincts, which show that it is at least possible that a complex instinct might have been acquired by successive steps ; and

* Kirby and Spence, *Entomology*, vol. ii, p. 161 (3rd ed.).

† *Ibid.*, vol. i, p. 380.

‡ *Ibid.*, vol. i, p. 280. A long list of several insects which either in their larval or mature condition will devour each other is given.

which moreover generally indicate, according to our theory, the actual steps by which the instinct has been acquired, in as much as we suppose allied instincts to have branched off at different stages of descent from a common ancestor, and therefore to have retained, more or less unaltered, the instincts of the several lineal ancestral forms of any one species: bearing all this in mind, together with the certainty that instincts are as important to an animal as their generally correlated structures, and that in the struggle for life under changing conditions, slight modifications of instinct could hardly fail occasionally to be profitable to individuals, I can see no overwhelming difficulty on our theory. Even in the most marvellous instinct known, that of the cells of the Hive-bee, we have seen how a simple instinctive action may lead to results which fill the mind with astonishment.

Moreover it seems to me that the very general fact of the gradation of complexity of instincts within the limits of the same group of animals; and likewise the fact of two allied species, placed in two distant parts of the world and surrounded by wholly different conditions of life, still having very much in common in their instincts, supports our theory of descent; for they are explained by it: whereas if we look at each instinct as specially endowed, we can only say that it is so. The imperfections and mistakes of instinct on our theory cease to be surprising: indeed it would be wonderful that far more numerous and flagrant cases could not be detected, if it were not that a species which has failed to become modified and so far perfected in its instincts that it could continue struggling with the co-inhabitants of the same region, would simply add one more to the myriads which have become extinct.

It may not be logical, but to my imagination, it is far more satisfactory to look at the young cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of the Ichneumidæ feeding within the live bodies of their prey, cats playing with mice, otters and cormorants with living fish, not as instincts specially given by the Creator, but as very small parts of one general law leading to the advancement of all organic bodies—Multiply, Vary, let the strongest Live and the weakest Die.