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movement of the northern and western species toward the south and east. Almost without exception the novelties included in the above list come from the north and west.

Among mammals the same is true, although the evidence is not so extensive. The Prairie Hare is the most marked case in point.

REPTILES.

The following species are not found in Prof. Osborn's catalogue. Specimens of each are in the University museum.

OPHIDIA.

- Eutamias saurita* (L.). Johnson county, Iowa.
Coluber guttatus, L. Rippey, Iowa. B. F. Osborn.
Diadophis punctatus (L.). Rippey, Iowa. B. F. Osborn.
Crotalus horridus, L. Iowa City, Iowa.

LACERTILIA.

- Eumeces septentrionalis* (Baird).

BATRACHIA.

Amblystoma jeffersonianum (Green), Baird. Specimens from Iowa in University museum.

FISHES.

The following species should be added to the list on the basis of specimens from Iowa in the University museum.

- Ammocetes niger* (Raf.), Jordan. Iowa City.
 [*Moxostoma microlepidota*¹ (LeS.), Jordan. Iowa City.]
Cliola forbesii, Jordan.² Iowa City.
Acantharchus pomotis (Baird), Gill. Iowa City.

SIGNIFICANCE OF THE CONCEALED CRESTS OF FLY-CATCHERS.

BY C. C. NUTTING.

In all the works on animal coloration that have come under my observation, there is a marked absence of any attempt to account for the concealed crests of bright colors on the crown of many birds, notably the *Tyrannidæ* or "Fly-Catchers."

The writer, although the first, so far as he knows, to offer an explanation for this class of facts, was for a long time compelled by press of other duties, to defer for a number of years any considerable investigation in this direction. Last summer, however, he took the time to examine the collection of *Tyrannidæ* at the Smithsonian Institution, probably the largest series of this exclusively new world group in the world.³

¹This is doubtless the same species that is entered by Meek in Osborn's list as *M. duguesnii*, and is therefore not a species new to the State.

²Synopsis of Fishes of North America. Jordan and Gilbert, 1882, p. 174.

³The writer wishes to take this opportunity to acknowledge the never failing courtesy and patience of Mr. Robert Ridgway in facilitating the examination of the splendid collection under his charge.

The facts ascertained by this examination were briefly as follows:

Out of sixty-one genera examined, seventeen contained species characterized by the possession of concealed crests, and forty-nine contained species without them. That is about twenty-six per cent of the genera contained species with these crests and seventy-four contained species without them.

It has been held that these crests afforded a good generic character among the *Tyrannidae*, but the facts just given would militate against this view, a generic character which fails six out of seventeen times being of very questionable value.

To one acquainted with the North American *Tyrannidae* only, there would seem to be a relation between large sized birds and the possession of these crests. *Tyrannus*, *Pitangus*, *Milonlus* and *Myiodynestic* are the largest of our Fly-Catchers, and they all possess concealed crests, while the remaining N. A. genera (seven) all comprise smaller birds none of which exhibit the crests.

An examination of all the genera of the family, however, shows that this distinction breaks down almost completely, the average length of those species with the crests being 6.53 in., and that of those without the crests being 6.47 in., an entirely insignificant difference which would be much reduced if the long-tailed species of *Milonlus* were taken out of the first class.

There is, as would be expected, a marked relation between the general color of the birds and that of the crests.

Thus out of seventeen genera with crests, thirteen had red or yellow crests associated with an absence of yellow in general color. Only two had red or yellow crests associated with white in general coloration, and one of these, *Milonlus*, showed red on the axillars.

Thus we see that in sixteen out of seventeen cases, or 94 per cent, there is a marked relation between the color of the concealed crests and the general coloration of the birds.

A condensed statement of the facts may be as follows:

First—About 25 per cent of the genera of *Tyrannidae* contain species possessing concealed crests.

Second—This crest has no reliable value as a generic character, holding good in only two-thirds of the genera.

Third—There is no relation between the size of the birds and the possession of concealed crests if we take the whole family into account, although in North America the largest species have crests, while the smaller have none.

Fourth—There is an obvious relation between the color of the crests and the general coloration of the bird, a large proportion of species with red and yellow crests, having yellow as a main feature of their general coloration.

Let us now attempt to explain the significance of concealed crests in the life of the birds. Their frequent occurrence would indicate *a priori* that they are of service to their possessors, and to point out that service is the main object of this paper.

In Vol V, page 396 of the proceedings of the U. S. National Museum is the first suggestion of the significance of these concealed crests that I have been able to find. It occurs in a report written by myself on a collection of birds from Nicaragua.

In discussing *Muscivora mexicana*, a species of Fly-Catcher with a marvelous fan-shaped, erectile crest, the following language is used:

“Is it not possible that this bird is provided with its remarkable crest for the purpose of attracting its insect prey, and that the slow and regular waving motion

is calculated to still further deceive by a simulation of a flower nodding in the breeze?"

I may add that further observations on the same species convinced me that my explanation was correct.

Mr. Charles W. Beckham, in a paper published a year or two later (which I am unfortunately unable to find), has the following to say in relation to the common "Kingbird" or "Bee Martin:"

"Several years ago I saw one of these birds occupying an exposed perch on a pear tree in bloom about which many bees were darting. Several times I observed that the bird caught the insect without leaving his perch, by quickly turning his head and grabbing them. My attention being thoroughly aroused, I noticed that many of them seemed to fly directly toward him, the majority seeming to 'shy off' at a short distance and change their course, but very few that came within reach escaped him. The question naturally suggests itself: Did the thrifty hymenoptera mistake the fully displayed orange-red crown (I could see that the crest was erected) for a flower?"¹

Mr. Beckham also quotes my own observations on *Muscivora mexicana* above referred to.

From that time to this there has been little attention paid to the matter, as far as I can ascertain. The later writers such as Wallace and Poulton have ignored the question entirely, although they recognize similar phenomena in regard to animals, and have grouped them together for purposes of discussion.

Wallace says:²

"Besides these insects which obtain protection through their resemblance to the natural objects among which they live, there are some whose disguise is not used for concealment, but is a direct means of securing their prey by attracting them within the enemy's reach."

"Only a few cases of this kind of coloration have yet been observed, chiefly among spiders and mantidæ; but no doubt if attention were given to the subject in tropical countries many more would be discovered."

Poulton in his "Colors of Animals," says:

"Special aggressive resemblance sometimes does more than hide an animal from its prey; it may even attract the latter by simulating the appearance of some object which is of especial interest or value to it."³

Mr. Poulton cites the case of the Asiatic lizard which is colored like the sand on which it lives. A fold of skin at the corner of the mouth is red in color and is "produced into a flower-like shape exactly resembling a little red flower which grows in the sand." This the lizard successfully uses as a decoy for catching its insect food.

Beddard is the only recent writer, so far as I have been able to discover, that alludes in any way to alluring colors among birds. After speaking of the alluring coloration of the lizard "fishing frog," etc., mentioned by Poulton, he adds:

"It is said that the brightly colored crests of many birds act in the same way as a lure. Here of course there can be no question of any special resemblance to a flower."⁴

And with this casual allusion Mr. Beddard leaves the question without discussion.

¹Quoted by me from Standard Natural History, Vol. IV, p. 499.

²"Darwinism," p. 210.

³"Colors of Animals," p. 72.

⁴"Animal Coloration," p. 188.

It seems strange that such a striking assemblage of facts as is exhibited by these concealed crests should have been left so long practically unnoticed by those who make a special study of coloration. A partial explanation may be found in the fact that no American has undertaken a serious study of coloration. The *Tyrannidae* are all American, and British writers have had little opportunity to study their habits. Another important consideration is that the writers on coloration have concentrated their attention almost exclusively on insects, and have passed over the birds with an entirely inadequate examination of these strikingly colored animals.

Let us now turn to the argument, which is based partly on elimination, partly on the study of the habits of insectivorous birds in general, and partly on direct observation.

According to modern ideas all special organs or characters are supposed to be of special use in the economy of their possessors.¹

Colors are useful to birds in many ways. These uses have been divided into four general classes, *protective*, *aggressive*, *directive* and *attractive*.

Protective coloration includes all cases where animals are helped in escaping their enemies by their colors, either by a resemblance to environment, which aids in concealment, or by a mimicking of dangerous or distasteful forms. This includes both true mimicry and warning coloration such as is exhibited by skunks, coral snakes, wasps, etc. It needs no argument to show that concealed crests do not come under this head.

Directive coloration furnishes a means by which individuals, particularly of gregarious species, may keep track of their fellows after being scattered. The crests of Fly-Catchers are probably concealed during flight and at any rate cannot be seen at a sufficient distance to be effective as directive colors.

Attractive coloration includes all cases when the colors serve to attract the attention and secure the favor of the mate. They are generally, among birds at least, secondary sexual characters and one usually considered to be a product of sexual selection. They are apt to appear in the male only, or to be especially intense in that sex.

One of the most notable peculiarities of the concealed crests of the Fly-Catchers is the fact that they are *invariably possessed by both sexes*. Among the sixty-one genera examined by me, there was not one in which the male alone had a true concealed crest, although in a few rare instances it was much more conspicuous in the male, and in one, *Muscivora mexicana*, the crests were equally conspicuous in both sexes, but crimson in the male and bright yellow in the female.

These crests, then, can hardly be regarded as secondary sexual characters, and hence, cannot be considered as coming under the head of attractive coloration in the technical sense of the word.

There remains but one more class of coloration, and that is *aggressive* coloration, which assists its possessors to capture their prey. It is the direct opposite to protective coloration; may be such as to aid an animal in stalking its quarry, or it may serve as a *decoy* to attract the prey within reach of the animal pursuing. It is evident that the bright crown patch of the kingbird can be of no service in concealing the bird from its insect food. Hence, by a process of exclusion we come to regard the concealed crests of Fly-Catchers as *alluring coloration*.

Of course, this reasoning is of little weight if taken alone. A much more im-

¹Rudimentary organs or characters would at first sight seem to be an exception to this rule; but rudimentary organs are, in nearly all cases at least, regarded as remnants of organs once functional and useful to their possessors.

portant step in the argument is taken when we discover that the *true concealed crests* are *always found among insectivorous birds*, and nowhere else, so far as I can discover, among American birds, at least.¹ They occur among the *Tyrannidae*, *Oxyrhamphidae*, *Pipridae*, *Tanagridae* and the *Regulinae*.

Now, all of these birds are essentially *insectivorous* and I have been unable to find

Now, when we add to these considerations and facts the observations of Mr. Beckham on the Kingbird, and myself on *Muscivora mexicana*, in which cases the crests were seen to be of direct service in alluring insects; the theory may be regarded as practically demonstrated, although a larger number of observations is greatly to be desired.

Another interesting fact is that all of these crests are *erectile*, and are conspicuous when erected, and partially or completely concealed when not erected. Insectivorous birds which are without these crests often erect the feathers of the crown when excited by anger or the proximity of food. I noticed last summer, while visiting Mr. Ridgway, that his pet song-thrush always erected its crown feathers when about to peck a fly from anyone's fingers, which was its habitual way of feeding.

Many *Tyrannidae* have yellow or red as part of their general coloration. Some of these colors at the bases of the crown feathers would be exposed when the feathers are erected in the excitement incident on the approach of insect prey. If this tended to benefit the bird by attracting the insects, natural selection would preserve and intensify it, and we may thus see the means or method by which concealed crests may have originated.

It may be suggested in conclusion that these concealed crests are probably among Nature's latest devices wherewith she has equipped her feathered favorites. The fact that they appear among the most highly specialized genera of the *Tyrannidae*, and are often specific and not generic characters, shows them to be lately acquired. Another indication of the same truth lies in the fact that, in many species, at least, the crests are acquired rather late in life, young birds having little or no trace of it.

PHENOLOGICAL NOTES FOR 1892.

BY L. H. PAMMEL.

It has always seemed to me that there is abundant room for such botanists as have little time to do original work to devote a few moments in taking notes on the leafing, flowering and ripening of seeds of our native and cultivated plants, in short everything that may be considered under the head of phenological observations. These observations, like those on the pollination of flowers may be made at odd moments and would be of great service to working botanists. If a few scattering botanists would only collect insects on various flowers and make field observations, then turn them over to a botanist like Mr. Roberts, it would be of incalculable benefit. So, too, in this phenological work botanists all over the country should make a few observations, bring them together so that some general conclusions

¹There may be other cases among Central and South American birds, as lack of time prevented my going through the whole series as carefully as I could have desired, a single well-defined concealed crest which is possessed by a non-insectivorous bird.