

PARASITISM OF BIRD'S NESTS BY PROTOCALLIPHORA
AT GROTON, MASSACHUSETTS¹

By EDWIN A. MASON

THE study of parasitism by *Protocalliphora* which was being conducted by Mr. Charles W. Johnson, of the Boston Society of Natural History, with the coöperation of several New-England banders, and which was reported by him in the *Bulletin of North-eastern Bird-Banding Association*, Vol. I, p. 52; Vol. III, p. 1; Vol. III, p. 77; Vol. V, p. 29, and in *Bird-Banding*, Vol. I, p. 169 and Vol. III, p. 26, has been continued at Groton, since his death. At the time of his passing Mr. Johnson had at the Museum the material collected during the season of 1932.

Mr. Johnson's usual procedure was to count the number of larvæ and puparia present in a nest as soon as they were received; he then placed them in covered jars to await the emergence of the flies. Later he would count the flies which had emerged and the puparia which had died, and would watch particularly for secondary parasitism by the chalcid *Mormonilla*. By this method of study it was hoped to get sufficient data to ascertain the species of flies responsible for the parasitism of the nests of birds in this section, and to determine what species were parasitic upon these flies, and to what extent. The year of 1932 was to have been the last year this particular line of study was to have been continued, but unfortunately Mr. Johnson died before he completed the work.

Upon inquiry, it was learned from Mr. Edward Wigglesworth, Director of the Boston Society of Natural History, that the Museum was at that time unable to continue this study, but that the material on hand would be made available if we cared to examine it. These examinations were made in November, and it is thought the resultant data have sufficient value to be published as a matter of record.

The parts of the following notes in quotation-marks are the rough field notes made when the nests were collected. Each original nest is given a number, as No. 1, and the handmade nests (see page 118) used by the same brood carry the same number with the addition of the letter "A" for the first nest and "B" for the second. These numbers have no relation to the numbers of the nest-boxes which are occasionally referred to.

PROTOCALLIPHORA NOTES

1932

1. "May 19. Bluebird. Nest changed, larvæ present." On its arrival at the Museum, Mr. Johnson reported it contained 46 maggots. When examined by the

¹A contribution from the Wharton Bird-Banding Station, Groton, Massachusetts.

writer in November it contained 34 puparia; 9 flies had emerged; 25 puparia were dead.

2. "May 19. Bluebird. Nest changed, larvæ present." On its arrival at the Museum, Mr. Johnson reported that this nest contained 43 maggots, some too small to pupate. When examined in November it was found that 40 flies had emerged and 4 puparia were dead.

3. "May 24. Bluebird. Young all dead in nest; one egg infertile." Mr. Johnson reported that this nest contained 40 maggots, most of them full grown. When examined in November it contained only 4 flies, and there were only 13 puparia from which flies had emerged. The discrepancy between these and Mr. Johnson's figures was probably caused by the presence of *Attagenus piceus*. Oliv. (Dermestid beetle). These were determined by Mr. Farold S. Peters, of the Bureau of Entomology, United States Department of Agriculture.

4. "May 27. Starling. Nest changed, one larva seen on a nestling." This nest, when examined in November, contained no signs of *Protocalliphora*, but 11 thin and comparatively long light-colored maggots, contained in a vial which was with the nest in a glass jar. Mr. Peters determined these as *Ceratophyllus Sp.* (Flea larvæ).

2A. "May 30. Bluebird. Replaced nest collected, 3 larvæ observed." In November, 20 flies were found to have emerged.

1A. "May 31. Bluebird. Replaced nest collected, larvæ present." The November examination showed the nest to contain 11 puparia from which 9 flies had emerged; 2 puparia were dead.

5. "June 3. Robin. Young left prematurely; one found dead beneath." When examined in November this nest was found to contain 18 puparia; 7 flies had emerged; 11 were parasitized by chalcids. Although the chalcid flies had emerged, none were found.

6. "June 6. Starling. Brood flown a day or so." This nest contained 12 flies when examined in November. The flies were nearly all partially destroyed, very likely by the meal-worm beetle and larva which were also found in the nest. These were determined as being *Tenebrio obscurus*, Fab., and *Tenebrio molitor*, L.

4A. "June 18. Starling. Replaced nest collected, one dead nestling." When examined in November this nest contained 27 puparia from which *Protocalliphora* flies had apparently emerged; 8 from which chalcids had emerged and 16 dead ones. No flies were in the jar.

11. "June 19. Tree Swallow. Nest changed, larvæ present." In November, this nest contained 32 puparia from which 24 flies had emerged; 8 puparia were dead.

12. "June 21. Chickadee. Nest collected after the disappearance of the only nestling; one larva noticed." One fly found when examined in November.

8A. "June 23. Tree Swallow. Replaced nest collected, many larvæ present." Contained in November 74 puparia; 30 flies had emerged; 38 were parasitized by chalcids; 6 were dead.

9B. "June 25. Tree Swallow. Nest collected, 4 dead nestlings, many larvæ." When examined in November this nest was found to contain a total of 144 puparia; one fly had emerged; 54 were parasitized by the little chalcid fly; 89 were dead. (It should be noted that this was the third nest used by this brood.)

13. "June 25. Bluebird. Nest changed, larvæ present." When examined in November it was found to contain 26 puparia; 22 flies had emerged, 4 were dead.

11A. "June 25. Tree Swallow. Nest changed, larvæ present." The November examination disclosed a total of 81 puparia in this nest; 65 flies emerged, 16 were dead.

11B. "July 2. Tree Swallow. Nest collected, brood flown." A total of 7 puparia were found when examined in November; 4 flies emerged, 3 were dead.

13A. "July 5. Bluebird. Replaced nest collected, young flown." When examined in November this nest contained 114 puparia; 88 flies, 26 puparia were dead.

14. July 11. Tree Swallow. Nest collected, *all nestlings dead*, larvæ present." This nest contained 82 puparia; 27 flies emerged, 55 were dead.

15. "July 11. Tree Swallow. Nest changed, larvæ present." The larvæ present in this nest—61 in number—failed to pupate and emerge as flies because they were too small when their supply of food was cut off by the collecting of the nest. There were also many unhatched fly eggs in the nest.

16. "July 14. Bluebird." In November this nest contained 40 puparia; 3 flies emerged, 37 were dead.

17. "July 15. Tree Swallow." This nest contained 98 puparia, 94 of which were dead; there were 3 from which flies may have emerged, and 1 in which was a dead fly.

17A. "July 19. Tree Swallow." This nest contained 39 puparia; 11 flies emerged, 28 were dead.

16A. "Aug. 1. Bluebird." A total of 35 puparia were found in this nest; 26 were parasitized, 9 were dead.

17B. "Aug. 1. Tree Swallow." This nest was parasitized 100 per cent, 9 of the 10 puparia still containing chalcid maggots when examined, as follows:

1	contained	44
2	"	29
1	"	27
1	"	20
1	"	17
1	"	8
1	"	5
1	"	3

Total..... 153

It will be noted that in the above data the different forms of *Protocalliphora* and of the secondary parasite *Mormoniella* are not distinguished, but, while this may be unfortunate, it is not thought greatly to reduce the value of the determinations.

The study of this subject as continued in the years 1933, 1934, and 1935 at Groton, was along slightly different lines, and, as always, the saving of the nestlings from death by the parasites was the primary thought in mind. The practice of substituting a hand-made nest for the original one, and again subsequently substituting others when necessary, had so proved its value in the saving of nestlings that it was continued, and further reference will be made to this subject later in this paper. When a nest was changed or finally collected after the nestlings had flown or had died, the material was examined, the number of maggots and puparia present counted, and a record kept. The maggots and puparia were then immediately destroyed.² This precluded the possibility, of course, of keeping a close check upon the secondary parasitisms, although a slight check on this phase was made by keeping a few nests in jars; otherwise the data collected are similar to those acquired from Mr. Johnson's method of study. By this method it is

²During the latter part of the season of 1934 and since the middle of June, 1935, the suggestion made by Mr. Lewis O. Shelley, of East Westmoreland, New Hampshire, that *Protocalliphora* puparia be saved in order to build up the population of the secondary parasite *Mormoniella*, has been acted upon.

still possible to determine to what extent *Protocalliphora* flies are present, and to make comparisons between different times of the nesting season, between individual nests, between nests of different species and between years.

The cumulative data covering the species most closely studied, are presented in Table I. Other host species of *Protocalliphora*, which were less thoroughly studied and on which the data collected are less conclusive, are Robins and Chickadees.

TABLE I

Host Species	Broods hatched	Broods from which numbers left nest	Total of nests both original and substituted examined	Total of larvae and, or, puparia found	Average per nest examined for season, May 17 to Aug. 27	Average for first half of season, May 17 to July 7	Average for second half of season, July 8 to Aug. 27	Highest number found in an individual nest	Lowest number found in an individual nest	Average number per brood hatched per season.
1932										
Tree Swallow	7	5	10 ³	628	63	67	53	144	7	89
Bluebird	6	5	9	376	42	43	37	114	11	62
Starling	3	3	3	40	13	..	..	27	1	13
1933										
Tree Swallow	9	5	24	1,176 +	49 +	49 +	0	250 +	0	130 +
Bluebird	5	5	11	403 +	36 +	35 +	38 +	86 +	0	80 +
House Wren	14	14	14	80	5.71	..	..	33	0	5.71
1934										
Tree Swallow	8	8	25	1,197 +	47 +	45 +	65 +	100 +	0	149 +
Bluebird	7	6	18	726 +	40 +	44 +	30 +	115	0	103 +
House Wren	14	12 ⁴	14	74	5.28	..	..	41	0	5.28
1935										
Tree Swallow	9	9	27	1,933 +	71 +	76 +	35 +	430	0	214 +
Bluebird	12	9 ⁵	31	1,091	35	28	45	160	0	91
House Wren	11	11	11	47	4.27	..	..	37	0	4.27
Starling	2	2	2	50	25	..	..	50	0	25

CASE HISTORIES

Number 1

Bluebird. No. 3, located in cowyard.

May 20. 5 eggs.

May 29. Hatched (5 nestlings).

June 1. Nest No. 7 collected: 60 medium and a few very small maggots. Estimated total 85 plus.

June 6. Banded 5 nestlings. The nestlings seemed a little cold and hungry.

June 6. Nest No. 7A collected: 13 large and 80 plus very small maggots.

June 14. Brood (4) dead a few days. As the nestling unaccounted for was too small to leave the nest of its own volition, it must have been removed, either dead or alive, from the nest.

June 14. Nest No. 7B collected: 21 mostly large maggots.

As the nest examined at the time the dead nestlings were found (No. 7b) contained only 21 maggots, mostly of large size, and one

³Sixteen nests were sent to Mr. Johnson, but no trace could be found of six of them.

⁴The two instances in which no member of the brood left the nest after successfully hatching, were accounted for by other reasons than the presence of *Protocalliphora*.

⁵See the three case histories which follow.

N.B. The figures which are given with the plus sign are estimated either wholly or in part.

nestling had disappeared from the nest, at least three possibilities present themselves.

The first is, that a predator (a Sparrow Hawk seen about the nest is suggested) harried the nest, carried off one nestling, and frightened the adults, causing them ultimately to desert the nest.

The second possibility, and a very unlikely one, is, that a nestling died from some cause or other, and the parents carried it away and later deserted the nest.

The third possibility, and perhaps the most likely one, is that the early, heavy infestation of *Protocalliphora* weakened the nestlings to such an extent that changing the nest did not give them sufficient respite, and the 21 large maggots, probably ones that remained fastened to the nestling's bodies when the nest was changed on June 6th, and so were placed back in the box when the birds were returned to the new nest material, continued to weaken the birds by their blood-sucking operation, finally causing death.

Number 2

Bluebird. Located on a pole between barns.

July 3. 4 eggs.

July 8. Hatched about 2 days (2 nestlings).

July 10. Nest No. 21 collected: about 70 very small maggots.

July 16. Nest No. 21A collected: about 110 medium to large maggots, mostly large, and a good many smaller maggots too small to count, estimated at 160 plus. One nestling dead and the other very feeble.

July 20. Nest No. 21B collected: 18 medium to small maggots. One dead nestling.

When the number of maggots feeding on this small brood is considered (248 plus), it leaves little room for doubt that the efforts made to minimize the effects of the maggots by changing the nest twice were unavailing in this particular case.

Number 3.

Bluebird. No. 6, situated in the cowyard.

This nest was robbed 4 days after hatching.

Tables II and III, which follow, are based on Table I. Table II gives the totals by host species for the four-year period. Table III gives the totals for each species for each individual year.

TABLE II.

	Broods Hatched	Broods from Which Members Left Nest	Total of Nests Both Original and Substituted Examined	Total of Larvae and/or Puparia Found
Tree Swallow (<i>Irido procne bicolor</i>)	33	27	86	4,934
Eastern Bluebird (<i>Sialia s. sealis</i>)	30	25	69	2,596
House Wren (<i>Troglodytes a. aëdon</i>)	39	37	39	201
Starling (<i>Sturnus v. vulgaris</i>)	5	5	5	90

TABLE III.

	<i>Total Larvæ or Puparia Found</i>	<i>Average Number per Broods Hatched</i>
Tree Swallow:		
1932	628	89
1933	1,176	130
1934	1,197	149
1935	1,933	214
Bluebird:		
1932	376	62
1933	403	80
1934	726	103
1935	1,091	91
House Wren:		
1932	0	0
1933	80	5.71
1934	74	5.28
1935	47	4.27

A case history covering the brood from which the highest number of maggots ever collected was taken is inserted herewith. It is interesting to note that the host species is the Tree Swallow.

Tree Swallow. No. 1. Located in the cowyard.

May 20. 2 eggs.

June 11. Hatched (4 nestlings).

June 14. Nest No. 14 collected: no maggots found.

June 21. Banded 3 nestlings: one dead nestling.

June 21. Nest No. 14A collected: 415 medium to small, mostly medium, and 15 large maggots. Total 430.

July 3. Nest No. 14B collected: 12 puparia. (Brood gone safely.)

Whatever the factors are which govern the adult *Protocalliphora* fly at the time it decides where and when to deposit its eggs, the data accumulated over the four years, and presented in the foregoing tables, prove that the Tree Swallow is the preferred host species in the area covered by this study.

Tree Swallows, and Bluebirds, the second common host species, are the only species endangered at this station by parasitism of *Protocalliphora*, and it is, of course, the large numbers of larvæ in the individual nest that endanger the lives of the nestlings. The other species found to have been the host of this fly, evidently are not preferred hosts, and a probable reason for the discrimination between the various species is the difference in nest-construction. When one observes the maggots squirming around in a dense mass about an inch below the cup of a nest, and sees the straw surrounding this active mass all broken into small pieces, it is not difficult to determine what it is that makes the loose stick nest say of the House Wren undesirable to *Protocalliphora*, and why it is that the Tree Swallow and the Bluebird are the preferred hosts. The color protection given the eggs of the fly by the usually white

feathers of a Tree Swallow nest, may also be a factor in the preference shown by *Protocalliphora* for the nests of this species.

While on the subject of preferred hosts and the reasons why they are selected, it may be well to add that it is very rare to find, in a nest collected after the brood has flown, maggots so small as to be not matured enough to pass into the puparium stage successfully, and hence valueless to perpetuate the species. This points to a highly efficient degree of selection of suitable sites for depositing eggs on the part of the female fly of *Protocalliphora*. There is ample indication that eggs are deposited up to the time the nestlings are half grown, but after that period this is evidently a rare occurrence.

The technique employed in the attempt to minimize the debilitating effects of the larvæ of *Protocalliphora* upon nestling birds of hole-nesting species, has gradually evolved into its present status as part failures pointed to flaws. The practice is not now perfect, but it is undoubtedly helping enormously to offset the depredations of this parasite. As an aid in understanding the subject matter of this paper, and in the hope that a knowledge of the technique may prove of value to others, a description of the successive operations is here given.

With the aid of a calendar-pad and a record of the condition of all occupied nests, it is possible in most cases to ascertain within a day or two the time of hatching of a particular brood. About four or five days after a brood has hatched, a visit is made to the nest. The nestlings are removed from the nest into a strawberry-basket, the basket being covered with something to protect the nestlings from winds and sun, and is placed upon the ground while the actual changing of the nest takes place. The original nest is swept out from the box into a double sheet of newspaper, care being taken not to spill any of the smaller particles usually found near the bottom of the nest box. This material is then tied into a tight bundle and is preserved to await examination later. Next comes the job of nest-making according to the best birdlike practices possible. A hank of soft hay can be tightly wound from one end, as though one were attempting to make a flat mat, working from the middle outwards, and subsequent hanks attached as the previous one is used up, until a big handful is secured. This is placed in the nest-box in a horizontal position, and should spring outward and upward when released. It should then be moulded with the clenched fist until a cavity is formed, and presto, the hank of hay has been turned into something like a bird nest which is accepted by the birds.

The adults are trapped when they enter the box to feed on the fifth or sixth days after hatching, and the male is caught first if possible. This practice applies chiefly to Bluebirds and Tree Swallows. Wrens, because they are less easily alarmed and because the sexes cannot be identified by their plumage, can very well both be caught on the same day.

Four or five days after the first changing of the nest, or eight or nine days after hatching, the nest should be again removed and another new one substituted. At this time the nestlings can be banded before being returned to the box.

As the nestlings at this stage are usually fairly large and vigorous, they are able to withstand the attack of a brood of *Protocalliphora* maggots, should eggs be deposited in the new nest by the fly, or if a few maggots persist from previous hatches on the bodies of the nestlings, and accordingly the nest is now left undisturbed until the nestlings have flown. The period of adolescence is usually not longer than twenty days, and so twelve days or so are allowed from the date of the second nest-changing until the last nest is finally collected. The practice of changing nests applies only to Tree Swallows and Bluebirds. In the case of other species the original nest only is collected, and that after the brood has flown.

SUMMARY OF TECHNIQUE

1. Determine date of hatching.
2. Four days later, collect original nest and substitute a new one.
3. Fifth or sixth day, trap-nest adult male. (In the case of Wrens trap both adults.)
4. Sixth or seventh day, trap-nest adult female.
5. Eighth or ninth day, change nest and collect second nest, and band nestlings.
6. Approximately twenty days after hatching, brood having flown, collect final nest.

The desirability of building up a large population of the chalcid *Mormoniella* to provide a natural check on *Protocalliphora*, makes it advisable to give this little fly every opportunity to complete its cycle on its host the *Protocalliphora* puparium, as pointed out by Mr. Shelley. Thus while it is desirable to destroy by burning all maggots found in the earlier nests collected, it is not desirable to destroy them after the period has arrived when they are likely to be parasitized by *Mormoniella*. Therefore from about the middle of June on, all maggots large enough to pupate and all puparia are placed in a tight box in the top of which is an aperture covered with mosquito wire which will allow the small chalcid flies to escape, but which will retain the larger *Protocalliphora* flies. This box can be used until such time as the first *Protocalliphora* fly makes its appearance, and then, so as to avoid the flies escaping, another box should be used.

As a means of illustrating what happens inside such a box as the one referred to above, the data on check broods of *Protocalliphora* placed in jars covered with cheese cloth are given here:

Nest No. 24.	
Aug. 3 (1933).	18 puparia placed in jar.
Aug. 18 (A.M.).	1 fly emerged.
Aug. 19 (A.M.).	10 flies emerged.
Dec. 20.	The jar was examined and the contents were as follows: 12 dead <i>Protocalliphora</i> flies. 5 puparia from which chalcids had emerged. 1 <i>Protocalliphora</i> puparium which contained 15 chalcid larvæ.
Total	18

Nest No. 8B.	
June 23 (1934).	55 puparia and 25 large maggots placed in jar.
July 4 (A.M.).	3 flies emerged, still with gray bodies. ⁶
July 8 (about).	Approximately 20 were estimated to have emerged.
July 18.	Some puparia still whole, and some from which chalcids had emerged.

The above data indicate that the secondary parasite has flies emerge the same year the egg was laid, but this does not happen in the majority of cases. The greatest number of chalcids come from larvæ which winter in *Protocalliphora* puparia, and emerge the following year. To substantiate this statement, a quotation is made here from notes made on the box containing the puparia collected from nests during the summer of 1934 and held over winter. "On June 17, 1935, a great many chalcid flies were in the box, and apparently were still emerging. They were scattered over the sides and in the bottom." The notation was also made at the time that there had apparently been a continuous emergence since about the middle of May, gradually increasing in intensity, and probably reaching its peak about the beginning of June. The box had been under observation since early May. On June 21st none were to be seen in the box, and about this time the first flies (chalcid) were noticed in nests. There seems to be a coinciding peak-emergence of both *Protocalliphora* and the secondary parasite *Mormoniella* about the middle of June.

Viewing the data from Table I by species, it is clearly shown in Table III that a constantly increasing number of larvæ or puparia have been observed. There is an ascending scale over the period except in the case of the House Wren, that either proves *Protocalliphora* is more abundant, or that a greater degree of efficiency has been obtained in recording the numbers present. It would seem that the latter has probably occurred to some degree, but, on the other hand, it is doubtful if to the extent the tables indicate. It is, therefore, most likely that *Protocalliphora* has increased in numbers at this station during the period under consideration.

⁶The flies attain normal steel-blue color an hour or so after emerging.

Protocalliphora is proved to be present at this station in large numbers. It seems fairly safe to assume that this parasite is present in such numbers that were it not for the steps taken to minimize its effect on the hole-nesting species, almost no Bluebird or Tree Swallow youngsters would ever fly from the nest-boxes at this station. This assumption is supported by the losses sustained during the period here reviewed (for example, see case-histories No. 1 and No. 2), and the losses sustained prior to this study and before the cause of the trouble was known. It should be mentioned in passing that occasionally a factor contributing to mortality from the activities of *Protocalliphora* is encountered in the form of inclement weather. A few consecutive days of wet and cold weather reduce the available food supply, and so lower the resistance of the nestlings to a point less than normal. It is on such occasions that an unusually high mortality may be expected.

The conclusions arrived at in the preceding paragraph are discouraging. An element of hope, however, is not lacking, since the adverse conditions obtaining at this station do not appear to be general. While reports of parasitism by *Protocalliphora* do come from other stations, and while the extent of its range and the results of its depredations have not been reported with any degree of thoroughness, it is known that a great many broods of Tree Swallows and Bluebirds do successfully leave their nests, even in our general region. There is thus presented a picture of spotty range and/or intensity of the *Protocalliphora* population. What the controlling factors are as yet is unknown to us.

Groton, Massachusetts.

RETURNS OF BANDED BIRDS: SECOND PAPER¹

(Shorebirds, Waxwings, Shrikes, Vireos, Warblers, Doves, and Pigeons)

By FREDERICK C. LINCOLN

IN the first paper in this series the data presented were (with a few exceptions) of birds recaptured at points other than that of banding. This will be the primary object throughout the series, but occasionally it may be desirable to include a few station returns, as when the species involved is one for which any kind of a "retake" is more or less of an occasion of note.²

For the purpose of providing a variety of interest, the present

¹ Correction: Recoveries of Banded Birds of Prey. *Bird-Banding*, Vol. VII, p. 44, January, 1936. In the first paper of this series two unfortunate errors were made as a result of using an old atlas for the purpose of computing distances. The atlas used was the Rand McNally 1915 edition, which shows the town of La Verne in Marin County. Apparently there is another town of this same name in Los Angeles County, and this is the one that figured in the recovery records of Screech Owls Nos. 290939 and A800862. Accordingly, the distance between points of banding and recovery for the former is about three miles and for the latter about two miles.

² Recoveries of Banded Birds of Prey. *Bird-Banding*, Vol. VII, No. 1, pp. 38-45, January, 1936.