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Mortality in Relation to Age in Young White Pekin Ducks with Blood-Induced *Plasmodium lophurae* Infection *

By E. R. BECKER

The extreme susceptibility of ducks to *Plasmodium lophurae* was first reported by Wolfson (1940) who noted both the high parasitemia and mortality that followed blood-inoculation of these birds. The course of the infection in ducklings has been studied by a number of workers, among them Hewitt, Richardson and Seager (1942), Rigdon and Varnadoe (1945), and Becker, Brodine and Clappison (1949), all of whom support Wolfson's findings. Marshall, Litchfield and White (1942) state that over a 4-month period they lost 95.1% of a total of 205 infected control ducks, the average survival time being 9.3 ± 4 days.

Hewitt *et coll.* made a study of mortality among infected ducks of different ages. The results of one study appearing in a table showed 50-60 percent mortality in birds 2-4 weeks of age and 80-85 percent mortality in birds 6-12 weeks of age. The results of another study reported graphically also tell the story of delayed death in the younger groups.

The mortality records reported here are mostly a by-product of experiments in drug-testing and immunity, and consist of data compiled from many groups of 4 to 10 untreated controls, in the case of the youngest ducklings, and from ducks intentionally infected for passing the microorganism or for the purpose of securing relapsing ducks, in the case of the older ducklings. Thus the experimental birds were a heterogeneous lot in that they were not all infected at the same time or with blood from the same passage duck. It may be commented that data collected in such a manner may have as true or truer significance than data obtained in a single experiment in which all the birds are infected at the same time from a single passage duck. The youngest ducklings, in the first category, were inoculated with 2×10^8 parasitized erythrocytes per bird, and the others with about 1×10^8 parasitized erythrocytes per kg. of body weight, except that in the case of the passage ducks the inoculum was not uniform. The protozoon has been maintained in the laboratory for several years by serial passaging through ducks every 4-6 days.

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RESULTS

The birds for which mortality records appear have been arranged in four categories, the first consisting of birds 12-19 days of age at the time of inoculation, the second of birds 42 days of age and older, the third of two groups 9 and 44 days of age, respectively, and the fourth, of a heterogeneous assortment of passage ducks. There were 142 ducklings in the first category. Their mean age was 13.4 days, and all were 12-14 days of age except 3 of 16 days and 7 of 19 days. The mortality record of these birds appears in Table 1. None of them died before the fifth day or on the eighteenth day, though a number died later. Under the column headed "19+" is recorded the number which either died or were still living on that day.

The table shows that 104 or 73.24% of the 142 ducklings died before the nineteenth day. Of those that died during that period, 77 or 54.27% of the total died within 5-9 days. This means that three-fourths of the 104 birds which were lost by the eighteenth day had succumbed by the end of the ninth day. The average survival time of these 104 ducks was 8.57 days. When these results are compared with Hewitt's graph, referred to above, it is apparent that our ducklings succumbed somewhat more rapidly than his, for his highest mortality was obtained on the tenth day with near-highs also on the sixth and seventh days.

The second category consisted of 26 older birds, of which 10 were 42 days, 10 were 70 days, and 6 were 126 days of age on the day when all of them were inoculated with 1×10^8 parasitized erythrocytes/kg. This dosage on the basis of body weight is only slightly under the 2×10^8 parasitized erythrocytes per bird employed in the first group. Every bird developed a heavy parasitemia, 8 succumbed on the sixth day and the other 18 on the seventh day. The average survival time of this group of 26 older ducks was 6.7 days!

In the third category were 2 groups of 10 ducks each, aged 9 days and 44 days, respectively. The maximum mean percent of parasitized cells in Group 1 was 77.3%, attained on day 4, and the same in Group 2 was 78.9% attained in Group 2 on day 5. Only 3 birds of Group 1 survived after 8 days and 4 in Group 2. After 11 days, 1 bird survived in each group, and these developed enough resistance to live until sacrificed 3 months later.

We had records of passage ducks through which *P. lophurae* had been passed serially 26 times in 153 days at 5- to 7-day intervals. These ducks, the fourth category, were a heterogeneous assortment so far as age is concerned, but they varied from 4-weeks-old to

Table 1
Mortality among ducklings 12-19 days of age according to day of infection.

Day of death	5	6	7	8	9	10	11	12	13	14	15	16	17	19+
No. of deaths	9	16	23	16	13	3	9	3	1	3	5	1	2	38
% of total	6.34	11.27	16.20	11.27	9.16	2.11	6.34	2.11	0.70	2.11	3.52	0.70	1.41	26.76
% of total cumulative	6.34	17.61	33.81	45.08	54.24	56.35	62.69	64.80	65.50	67.61	71.13	71.83	73.24	100.00

about three-fourths grown. All but 6 of these 26 passage ducks died before the ninth day of the infection. Of the 6 survivors, 1 died on the thirteenth day and 5 survived until they were sacrificed.

These 5 surviving ducks apparently possessed considerable innate immunity, for 3 of them had less than 3.0% parasitized erythrocytes on the fifth day when the parasitemia should have attained 70-90%. The other 2 developed parasitemias of about 65%, but recovered.

SUMMARY

The observations of Hewitt *et coll.* and of Marshall *et coll.* that young ducklings succumb less readily to *Plasmodium lophurae* infection than older ducks is confirmed. This fact is not in accord with the generally accepted hypothesis that the resistance of animals to infection with animal parasites increases as they grow older (Cf. Sandground, 1929). In other words, ducks exhibit reverse age resistance, in contrast to chicks which become more resistant as they grow older.

The high mortality of the duck hosts in our laboratory suggests that the regular schedule of passaging keeps the microorganism highly virulent.

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