SOME RESULTS FROM ADULT TERN TRAPPING IN THE CAPE COD COLONIES.[1]

By OLIVER L. AUSTIN, M.D.

THE Cape Cod tern population comprises three large colonies varying from 20,000 to 40,000 breeding individuals, six or seven smaller groups of between 200 and 2,000 birds each, and a yearly increasing number of still smaller units scattered widely along the beaches. Each larger group is augmented by a considerable number of individuals which either have not arrived at the procreative age or have passed it.

Yearly variations in ecological conditions change the size of these individual groups, but adult trapping and failure to take elsewhere along the Atlantic coast during the nesting season birds banded on Cape Cod, show that this population is coherent, augmenting and also replacing inevitable losses by its own reproduction alone. About forty miles south of the nearest of the Cape colonies, in Nantucket Sound—this being the same as the distance between the extreme Cape groups—are three large tern rookeries, yet of the 4,983 returns trapped in the Cape colonies only twenty-six were banded on the Nantucket Islands.

Equally distant from the Cape Cod and Nantucket groups is a colony of several thousand nesting terns on Ram Island, investigated by us this year for the first time. In it seventy adults were trapped, of which thirteen or 18.6 per cent were returns. Of these last, six were banded as adults in one of the Cape colonies, four while chicks in the Nantucket group; seven were banded in 1935-36, and six in 1933-34. Only one tern banded there has been taken on the Cape.

Tern banding has been done on Cape Cod since 1922, for several years in smaller numbers, intensively for the last five seasons. There have been banded here 95,984 chicks and 16,723 adults, totaling 112,707. A resumé of the work already done was published in 1934. A perusal of this and other articles published in *Bird-Banding* dealing with the Cape's terns will orientate a readier and clearer picture of this report. For the last three years in our work with the *Sterninæ*, adult trapping has been the major undertaking of this Station, 11,416 adults having been banded and 4,624 returns taken in the Cape groups during this period. In all there have been 4,983 recaptures of banded terns.

The only satisfactory and safe method of taking adult terns is trapping them individually on their nests. This fails the day the eggs hatch, for at once the chicks seek the shelter of nearby verdure or litter, returning to the nests only for periodic brooding or feeding. The instinctive impulse for adequate incubation which impels terns

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unhesitatingly to enter traps over their eggs ends with hatching and seldom will a parent enter a trap placed over chicks in its nest. A simple drop trap of chicken-wire, two and one-half feet square with sides five inches high is used. Originally this was tripped by a string running from the supporting stick to a blind. Takes were unsatisfactorily few by reason of time consumed in setting traps; the continuous presence of humans in one small sector of a colony not only inhibited a return to the nests but also incited emigration and renesting elsewhere, especially early in the season. Almost always terns alight a short distance leeward and walk into the wind onto the nest. They arise from the nest into the wind, especially if alarmed. Consequently if the rear of a drop trap is placed on the ground to windward of a nest, the front elevated and balanced delicately on a slender stick, a departing bird, by touching the top of the trap, springs it immediately. Such sets, in groups of ten to twenty each, the groups from fifty to one hundred yards apart, increased the captures greatly. Working at these groups in rotation disturbs the breeding to a minimum. Efficiency is enhanced by small changes in the method of setting traps determined by variations in the wind, temperature and sunshine. It is possible to take almost every bird entering a trap by a simple arrangement of strings close to the ground between the supporting stick and the sides of the trap but this has been discarded for it entails both egg breakage and injury to the birds.

No method of capturing the "drone" members of a group which idle in rows along adjacent beaches has been found, but their presence has been shown by the taking of three different birds on a specified nest. This behaviour is only the vicarious release of immature sex-impulse and not the utilization of surplus labor, for, normally, communism is never exhibited by terns.

If the imperative reproductive accomplishment of a colony is to be conserved adult trapping must be done with judgment and restraint. Frequent rest days must be given whole colonies as well as sections of them, unsprung traps must often be removed *en masse*. In 1936, concentrated trapping resulted in extensive emigration and renesting on other sites. When these birds were retrapped subquently the same season it was found that they had not scattered as individuals but frequently had relocated in compact units duplicating largely their grouping in the primary nestings.

Three species comprise the Cape Cod colonies, *hirundo*, *dougalli* and *paradisaea*, in a rather consistent proportion; two-thirds are *hirundo*, one-third *dougalli* with, at most, four hundred *paradisæa*. The higher survival rate of *dougalli* chicks compensates the relatively larger broods of *hirundo* chicks to maintain partially this ratio, also the greater virility and adaptability of *dougalli* result in more frequent and longer adult survival. The divergent behaviour of the *dougalli* makes trapping them far more difficult and is responsible for the following:

Living adults trapped in	*1935*	*1936*	*1937*	*Total*	*Per cent*
Hirundo.....	3,732	6,882	4,501	15,115	96
Dougalli.....	239	427	21	687	4

This same species ratio of captures holds good, with explicable variations, for the work of all preceding years. *Hirundo* elects to nest in open terrain; *dougalli* sites are only in densely vegetated territory when available. Traps cannot be operated in locations of the second type without the removal of the greater part of the grass or plants. The likelihood of nest desertion is in direct relation to the degree to which nest surroundings have been altered. Usually, the *hirundo* reproduction cycle is two weeks in advance of the *dougalli*, the bulk of the latter species arriving on breeding grounds a week after the majority of the former, but courtship is delayed a week, not beginning at once as it does with *hirundo*. In 1936 at Tern Island, our largest and earliest breeding colony, for two and one-half weeks *dougalli* constituted 75 per cent of the population and nest-scooping began at once. This permitted trapping them before the beach-grass had grown enough to necessitate its removal and resulted in an unusually large take.

It is grieviously erroneous to compare bird behaviour with that of humans, for into the latter enter important determining factors foreign to the former. Nevertheless the actions of both are similar to a degree when they are either the outcome of unalloyed biological urge or are but crudely modified by most elementary psychological processes. The safety in numbers, the lack of ordinary caution by masses and the vigilance of settlers explain the divergent reaction to trapping by large and small colonies. The smaller and younger the colony, correspondingly greater is the difficulty experienced in trapping it from the standpoints of time consumed, number of possible takes and the inhibition of incubation. Annually, a group of from ten to fifty Arctic Terns nest on an extensive, unbroken, unvegetated sand-spit at the end of Nauset Point. It has never been possible to trap more than six of these during a nesting. Billingsgate Island is exactly similar terrain, but since between 1,000 and 3,000 individuals, predominantly *hirundo*, nest there and far more compactly, the trapping is almost as productive as it is in the two large rookeries. However, each revisit to this colony in one year affords almost geometrically less in trapping yield, while at Tern Island, if other factors affecting trapping are equal, takes from each set do not decrease as the season advances. Evidently psychological reaction to an important occurrence and behaviour adjustment are greater and more prompt in small than in large groups.

TABLE 1

ADULT TAKES 1928 TO 1937, INCLUSIVE

Year	*Banded*	*Returns*	*Total*	*Banded Per cent*	*Return Per cent*
1928.....	164	5	169	97.03	02.98
1929.....	918	31	949	96.73	03.26

1930	248	16	264	93.9	06.1
1931	86	11	97	....	....
1932	1239	80	1319	94.00	06.00
1933	2648	209	2857	92.68	07.32
1934	4	7	11	....	....
1935	3425	629	4054	84.43	15.52
1936	5435	1990	7425	73.20	26.80
1937	2556	2005	4561	56.05	43.95
Total	16723	4983	21706	77.04	23.06

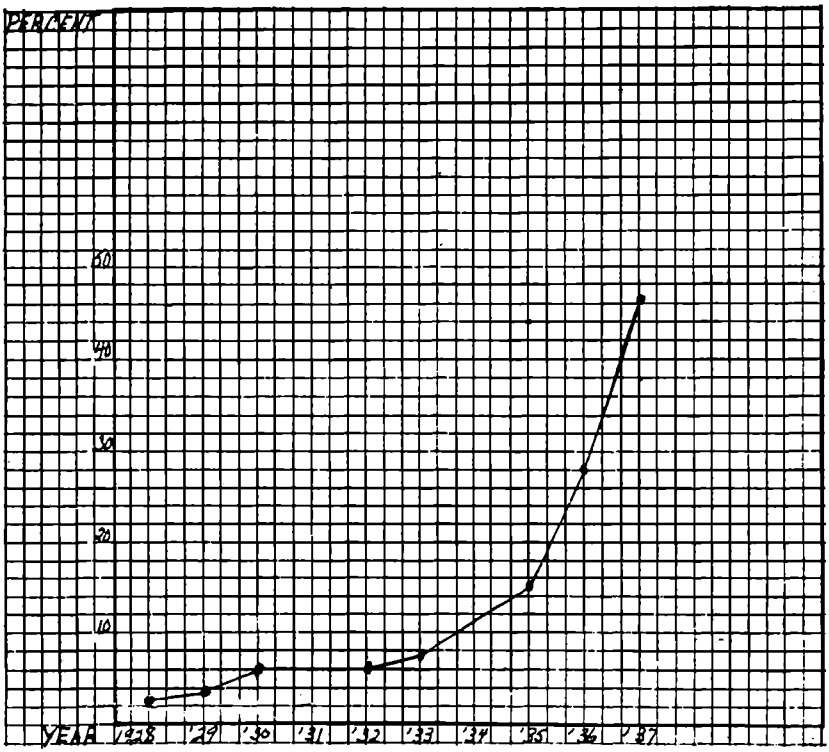
TABLE 2

RETURNS 1928 TO 1937, INCLUSIVE

Year	*Banded as Juveniles*	*Per cent*	*Banded as Adults*	*Per cent*	*Total*
1928	5	100.	0	0	5
1929	28	90.32	3	09.68	31
1930	10	62.5	6	37.5	16
1931	6	54.55	5	45.45	11
1932	38	47.5	42	52.5	80
1933	78	37.32	131	62.68	209
1934	0	0	7	100.	7
1935	181	28.75	448	71.25	629
1936	328	16.47	1662	83.52	1990
1937	363	18.11	1642	81.89	2005
Total	1037	20.88	3939	79.15	4983

The tables above summarize all adult takes in the Cape Cod Colonies and show some trends of the work being done. For analytical purposes the sampling may be considered representative and adequate excepting for two of the years: In 1931, the captures were few in comparison to other seasons, they were in groups atypical in composition by species and previously banded individuals, consequently their obvious inconsistencies both in numbers and percentages must be discarded. In 1934, in order to determine the efficiency and actual accomplishment of experimental conservation measures, disturbance of nesting birds was minimized by limiting trapping to the capture of eleven adults desired for particular individual study. That seven, or 64 per cent, of these were returns is dismissed as an artifact. These two hiatuses, however, are inconsequential in the determination of trends for both were preceded and followed by several years of typifying takes. Although the data presented in the tables are sufficient, both in volume and in the span of years covered, to warrant credible deductions these must not be considered conclusive and final, for facts obtained during the last three years have confuted earlier concepts of breeding ages and survival rates.

The rapid yearly rise in the percentage of returns in a season's takes (see graph number 1) condones any sacrifice of conservation resulting from capturing a large quota in a colony. So high is chick mortality and also that of juveniles—approximately ninety-five per cent of birds killed on the winter range are birds-of-the year—

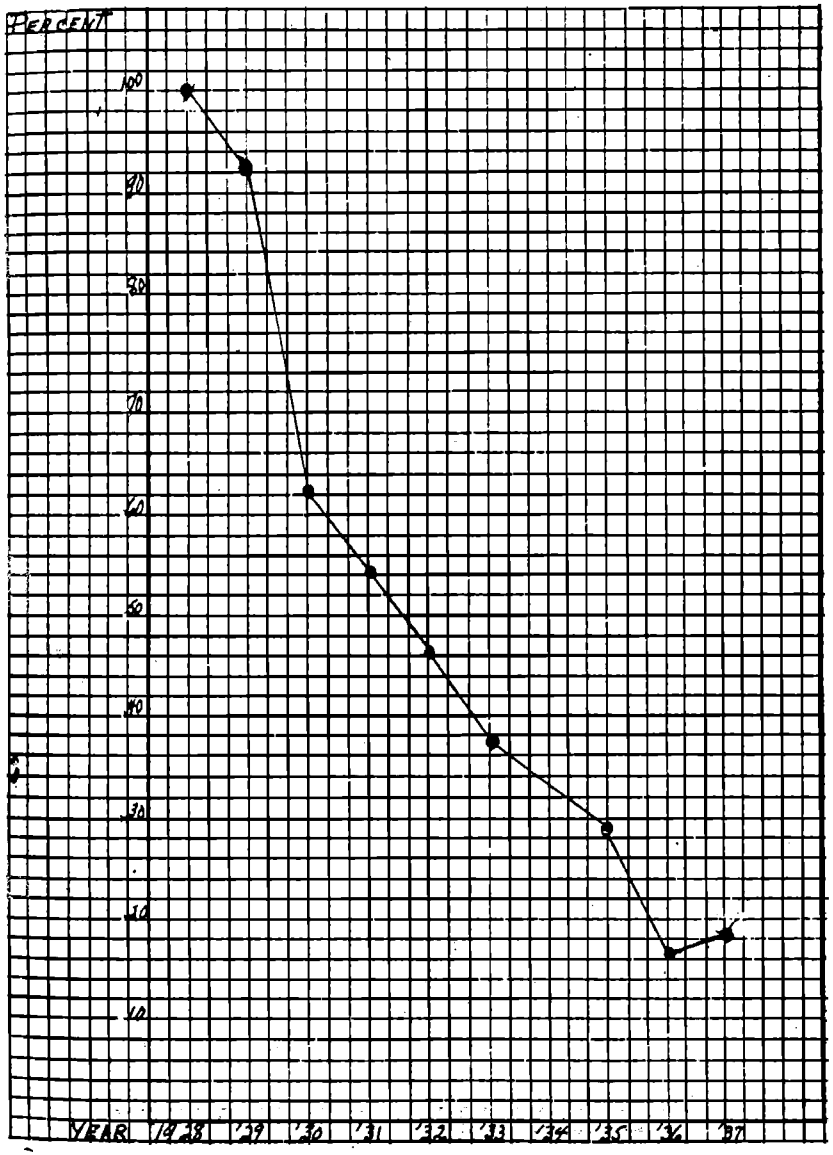


GRAPH 1

Graph 1 is based on the percentage of returns in the total adult takes for each year.

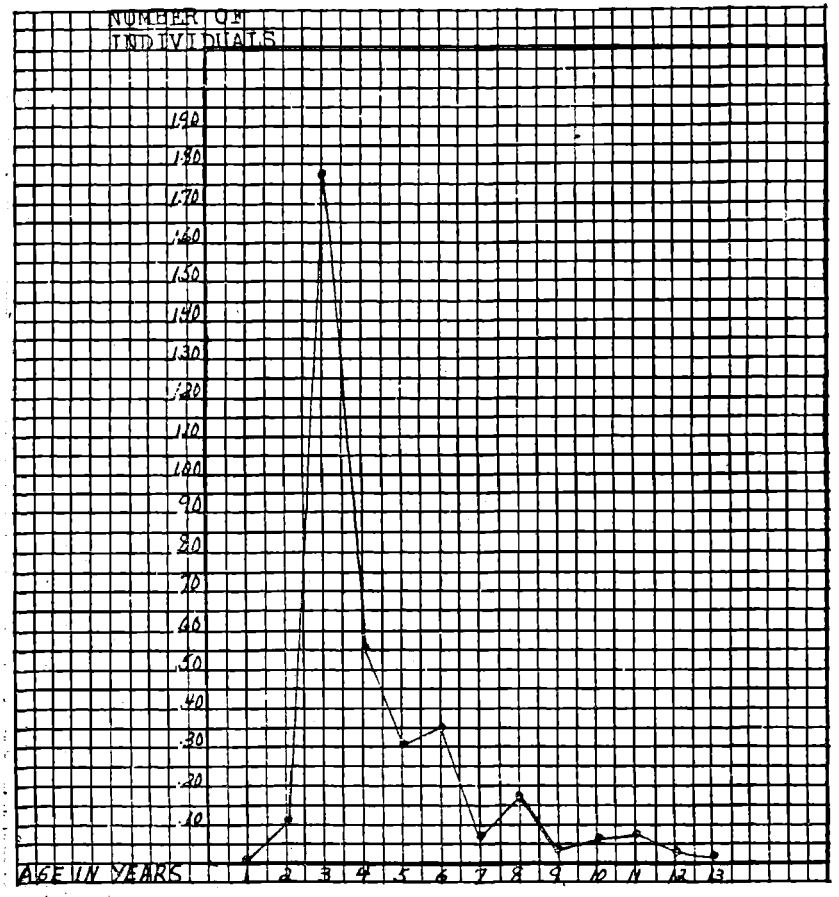
that bandings done at these ages give an incomplete and erroneous picture of the composition of a colony. For the first seven years the returns were consistently below ten per cent showing no rise paralleling the increasing number of chick bandings. As a result of the magnitude of adult bandings since 1933 the percentage of returns increased in 1937 to 43.95 per cent. This and other corroboratory findings suggest that the bulk of a colony, on which its prosperity depends, consists of adults in the prime of life, gregarious from the standpoint of clanship. As a corollary to this it appears that the perpetuation of these terns, provided requisite ecological conditions prevail, depends not on augmentation by very large numbers of juveniles but on the well-being and success of this group of physically mature and perfect adults possessing an adaptability greater than that of the average for the species.

The terns are well specialized species at best, but the juveniles are more exacting than adults in the requisition of agreeable en-



GRAPH 2

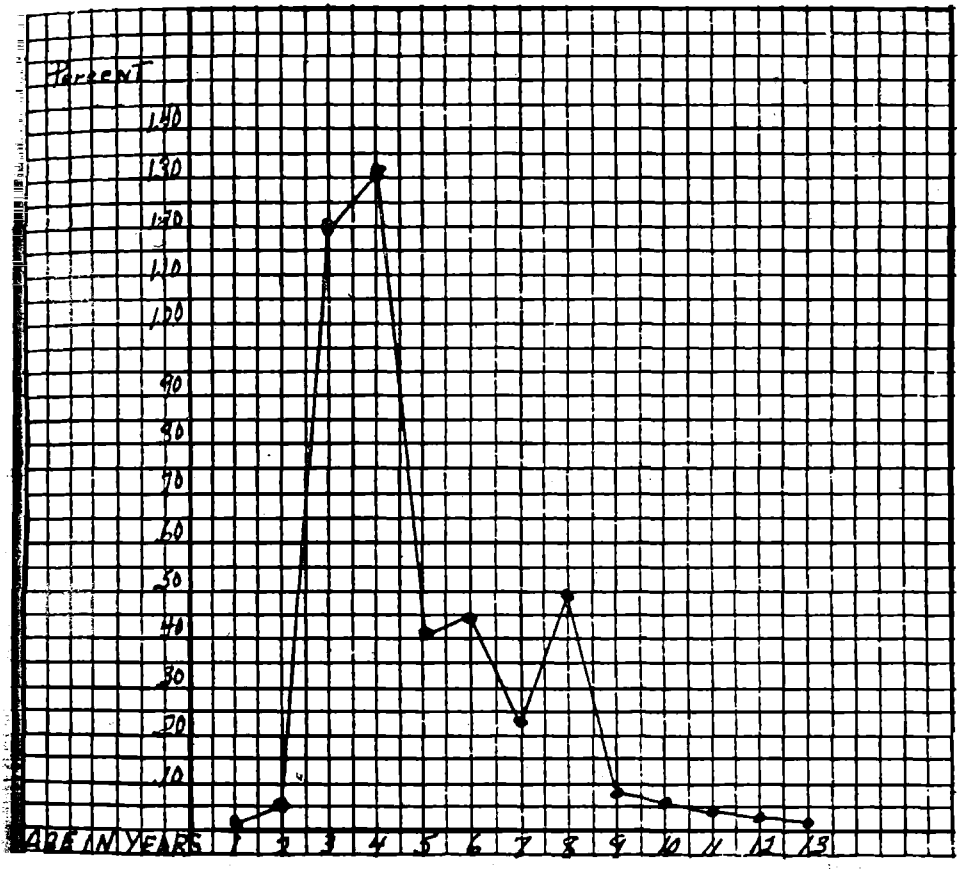
Graph 2 is based on the percentage banded as chicks in each year's total returns.



GRAPH 3

Graph 3 is based on the ages of returns taken in 1937 which had been banded while chicks.

vironment if they are to survive and procreate successfully. The presence of humans, molestation by an owl, and similar minor interferences drives them to prompt nest-abandonment whereas only some major catastrophe such as a serious food shortage or the destruction of all their eggs will force the virile, tenacious adults to emigrate for renesting. Birds nesting for the first and less often the second time rarely have more than two eggs in their clutches, commonly but one, and we have no record of four eggs having been laid in an initial nesting. More mature individuals always have at least two eggs, most frequently three and very often four. After making generous allowances for all known and suspected influencing



GRAPH 4

Graph 4 is based on the ages of returns taken in 1937 which had been banded while chicks and shows the percentages of returns of various ages to the total number of chicks banded in the respective years of birth.

conditions, it cannot be shown that the size of any year's hatch and chick survival has any corresponding increase or decrease in the whole Cape's or a particular colony's population three and four years later, the known time for breeding by these birds to begin. Graph No. 2 accentuates the relative unimportance of juvenile replacement and accretion especially since gaps made by death in the hardy group are filled by birds of duplicating age dispersed from other colonies. The final eighteen per cent cannot be the probable annual juvenile accession for in 1937 our reclamation work afforded unprecedentedly suitable conditions for juvenile nesting and is

responsible for a rise rather than a beginning leveling off of the curve in the graph.

In earlier articles dealing with the Cape Cod terns there were postulated and given as much proof as the available data warranted, statements concerning the breeding ages of terns. Since these were based on the exceedingly small number of ninety-seven individuals of known ages with a minimum allowance for possible variables it has appeared to be advisable to check the correctness of these findings by a comparison with the data since obtained.

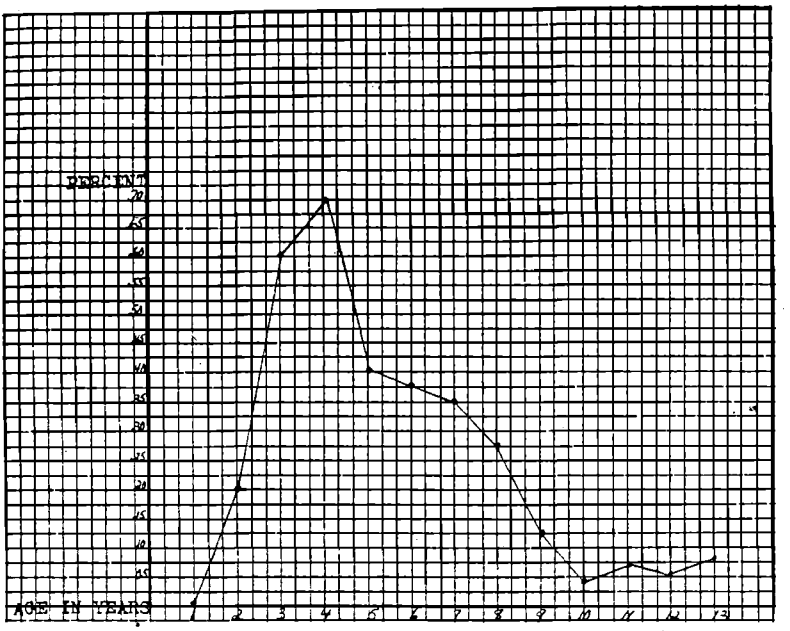
Returns banded as chicks taken in:

1935	181
1936	328
1937	363
Total	872

When the 1937 takes of birds banded while chicks are plotted (see graph No. 3), the ordinate representing the number of birds of known ages and the abscissa showing the ages, the picture corresponds almost exactly with the one obtained in 1932. Both these chartings fail to minimize the error inevitably consequent to wide variations in the number of yearly chick bandings. This fallacy is best eliminated by plotting the takes of each age in percentage of the total chicks banded. When this has been done (see graph No. 4), a picture is presented more like the unconfirmed impressions acquired while working in the field and compiling records. Discarding the recaptures of many birds a second and third time in years subsequent to their initial return, we have accumulated a total of 1,037 individuals banded the season of their hatching and trapped on nests thereafter between 1929 and 1937 inclusive.

When this huge sample is mapped by the percentage method used in graph No. 4, each point being the average for the combined years correctly superimposed according to ages (see graph No. 5), a reliable basis for deduction has been established. If it were possible to alter the locations of several points by utilizing numerous known occurrences and vagaries of chance which have caused distortion from absolute fact, a fairly smooth curve could be constructed with the second year mark much lower, the fourth year peak still higher than it is and the fifth and sixth year positions close to the descending arc.

Since we know that egg-laying by a tern the summer following the one of its birth, if it does occur, is anomalous, also that incubation the following year is a precocious and usually futile expression of an incompletely developed sex-urge, it appears that terns do not begin procreating actively until the end of their third year, attain maximum accomplishment in their fourth, retain high but slowly decreasing fecundity for three years more, then rapidly decline until, at decade, they reach almost at zero a level at which they



GRAPH 5

Graph 5 is constructed exactly as was Graph 4, but the points, rather than being the percentages for a single year, are the average for all the years 1929 to 1937, inclusive.

remain for the remainder of their lives. Without even intimating in this contribution our opinion concerning the longevity of terns, it is believed that the relatively small number of takes of breeding birds ten and more years old is due to mortality rather than to involutionary processes with resulting sterility. Only from incredible analogy can it be assumed that wild birds survive to a terminal period of propagative impotence. Care has been taken to follow through the nesting of a number of thirteen-year-old individuals. Their clutches are always average or larger, the fertility of their eggs is normal, and their chicks offer no evidence of physical inferiority. These relatively old birds present plumage changes, such as marked whitening of the feathers on the crown, which render them easily recognizable by any observing bander who has handled many thousand adults. Never have we been able to find them in the large groups of non-breeding birds frequenting the shorelines; always we have succeeded in retrapping them on their original nests.

Our lack of banding evidence of breeding by terns more than thirteen years old is no criterion for assuming that fecundity terminates at this age. Almost all of the bands on birds more than ten

years old are worn so thin that they are open for one-eighth of an inch or more, and they frequently fall apart when handled. We have found repeatedly, when these birds have been recaptured seasons subsequent to the one in which an additional band had been placed on the other tarsus, that the original band had disappeared. At Tern Island we have never taken a bird more than ten years old beyond the limits of one small sector of the large nesting area; we know that many terns, by election, return year after year to nest on the same particular spot in a rookery even more consistently than many passerine birds renest in an identical bush or box. Consequently when in the same area, we trap annually a number of unbanded birds which, because of their exhibition of the plumage characteristics previously mentioned, are probably of advanced age, it is likely that either they have lost their worn out bands, were missed when their contemporaries were ringed, or even were hatched before banding was initiated on the Cape.

Sixteen consecutive years of tern banding in this geographically rather isolated Cape group afford ample ground work for determining the methods by which a new colony is founded, appraising its make-up and estimating its potentialities, especially since this span of time includes fifteen years of wholesale chick-banding and six seasons in each of which from 1,000 to 7,000 adults have been taken. A decade and one-half ago, on Jeremys Point, a colony of several thousand birds was approaching the peak of its prosperity. Before the usual factors which determine the inevitable decadence began functioning, this colony became over-run by mammal predators which decimated its population annually, for its was situated on a peninsula. The late Mr. Forbush with others attempted in vain to rescue the rookery by building a wire fence across the narrowest part of the isthmus. This failed to check the inroads by numerically increasing predators and this molestation, the cause usually of only partial and transitory departure of a group of terns routinely tenacious in site occupancy, became the determining cause of the entire colony's scattering to Tern, Egg and Billingsgate Islands, at the moment ecologically ideal for a colonial nesting. Annually, since 1929, we have prospected this site adequately enough to be certain that not one pair of terns has nested. In mid June, this year, strictly local food shortage, shrinkage and destruction of available nesting territory with other unusual disturbing occurrences determined a patent emigration of nesting birds from the three largest Cape groups. At this time shell-fishermen who work daily in the vicinity of Jeremys Point sent us word that a large group of terns had begun nesting there, a full month after the reoccupation by its usual population of Billingsgate Island less than two miles distant. The site has become insular when the tide is very high and is ecologically ideal from the standpoint of the desideratum of breeding Common Terns. We found a colony of over 2,500 birds, overwhelmingly *hirundo*, nesting actively and we succeeded in

trapping there 425 adults, of which 141, or 33 per cent were returns. Of these takes only three were *dougalli*, one *paradisæa*, all unbanded.

If the ornithological dictum that the young of most species, when they reach procreative age, scatter to the occupancy of new territory applied to terns, certainly there would have been some few individuals nesting on Jeremys Point last year or at least within two and one-half weeks of the general Cape nesting this year, which did not occur. The seventeen day margin is allowed since work done from the first days of several years' reoccupancy at Tern Island and Egg Island, the former always from ten to fourteen days in advance of all other Cape groups in the whole nesting cycle, has shown that the oldest birds are the first to return, nest and incubate, those three or four years younger are a week slower, whereas the youngest returns nest in the more scantily occupied and less desirable territory about two weeks after the initial egg-laying.

But the best evidence that this new settlement did not originate in selection by a group of juniors of an unoccupied tract is found in the analysis of the captures here of birds of known age. While, in percentages, the ages duplicate closely in most respects those found to prevail in the oldest colonies, there is a much higher proportion of individuals four years old, the peak of tern virility. Two-year-olds were but one-tenth the usual ratio; not one 1936 chick was captured. On the other hand, only one bird at least seven years old was taken and of those known to have nested elsewhere earlier in the year but one of six years. This, of course, confirmed anticipations for when, in a large colony, disruptions of any sort produce a considerable renesting, the more senile birds repeat their undertaking on the original site. The probable correctness of these findings is corroborated by the constituency of other young and much smaller Cape flocks.

It is demonstrable that this Jeremys-Point colony was founded by an aggregation of birds in the prime of life compelled to forego the occupancy of the site they normally would elect by reason of its being unavailable or untenable. In all the colonies there are each year some few individuals who are either regularly or seasonably nomadic, but the percentage of such birds in this new group was many times greater than previously found elsewhere. Since this behaviour may be due to a relatively late hormone development obviously these individuals, their normal nest sites preëmpted, would ally with a flock seeking a new site. For their first nestings of the season birds came to Jeremy's from ten different locations, even from the Nantucket colonies, and also from Pamet Point, Little Sipson and North Point where conditions showed no influencing change from those of former years. But the preponderance of possible primary nesting birds, 66 per cent of all the returns, came from sites without usable terrain. From Egg Island, where rapid erosion has so abridged the land that nests were everywhere in a proximity both unprecedented and inconsistent with average

reproductive survival, came 28 per cent of these; from Billingsgate Island, similarly destroyed by the elements, came another 20 per cent, while 43 per cent were from Tern Island, where, while suitable territory exceeded by twice that of the preceding year, there was so great a dearth of sand eels and minnows which constitute the usual tern dietary that surface feeding on minute forms of ocean life was resorted to. Of the banded birds taken at Jeremys Point, 27 per cent were renesting birds trapped earlier in the year at other sites; of these 74 per cent were first caught while incubating at Tern Island and in age were within the three year epoch of the maximum reproductivity of terns.

In this paper a few statements have been made which were based largely on field work and observations; for most of these there are several duplicating or confirmatory entries in our daily notes. All others have been made only after verification by tabulations, charts and graphs constructed solely from the meticulously detailed recording of each take. In order to save the space necessary for their publication these have been omitted, but, together with many not utilized, they are available to those who desire making their own deductions or for supplementing those which have been made.

BIBLIOGRAPHY

AUSTIN, O. L.
1932. "The Status of Cape Cod Terns in 1932." *Bird-Banding*, Vol. III, No. 4, October, 1932, pp. 143–156.
1934. "The Status of Cape Cod Terns in 1934." *Bird-Banding*, Vol. V, No. 4, October, 1934, pp. 155–171.

AUSTIN, O. L., JR.
1929. "Contributions to the Knowledge of the Cape Cod Sterninæ." *Bull. N. E. B. B. A.*, Vol. 5, No. 4, October, 1929, pp. 123–140.
1930. "The Statistical Trends of Banding." *Bird-Banding*, Vol. I, No. 1, January, 1930, pp. 20–28.
1932. "Further Contributions to the Knowledge of the Cape Cod Sterninæ." *Bird-Banding*, Vol. III, No. 4, October, 1932, pp. 123–139.
1933. "The Status of Cape Cod Terns in 1933." *Bird-Banding*, Vol. IV, No. 4, October, 1933, pp. 190–208.

BAYNARD, O. E.
"Foods of Herons and Ibises." *The Wilson Bulletin*, No. 81, Vol. XXIV, pp. 167–169.

BENT, A. C.
1921. "Life Histories of North American Gulls and Terns." Smith, Inst., U. S. Nat. Mus., *Bull.* 113, 1921, pp. 236–264, 109–112, 160–161.
1926. "Life Histories of the North American Marsh Birds." Smith, Inst., U. S. Nat. Mus., *Bull.* 135, 1926, pp. 207–208.

BREWSTER, W.
1879. "The Terns of the New England Coast." *Bull. Nuttall Ornithological Club*, Vol. 4, No. 1, January, 1879, pp. 13–21.

FLOYD, C. B.
1925. "Six Days in a Massachusetts Tern Colony." *Bull. N. E. B. B. A.*, Vol. I, No. 4, October, 1925, pp. 58–60.
1926. "Additional Experiences in Banding Terns at Tern Island." Chatham, Mass., *Bull. N. E. B. B. A.*, Vol. II, No. 4, October, 1926, pp. 68–72.
1927. "Notes on the Development of Young Common and Roseate Terns." *Bull. N. E. B. B. A.*, Vol. 3, No. 4, October, 1927, pp. 95–101.

1928. "Notes on Banding Terns at Chatham, Mass., for 1928." *Bull. N. E. B. B. A.*, Vol. IV, No. 4, October, 1928, pp. 125–132.
1929. "Notes on Banding Terns at Chatham, Mass., for 1929." *Bull. N. E. B. B. A.*, Vol. V, No. 4, October, 1929, pp. 144–148.
1930. "Further Banding Notes from Tern Island, Mass." *Bird-Banding*, Vol. I, No. 4, October, 1930, pp. 181–184.
1932. "Report of Tern Banding on Cape Cod During 1932." *Bird-Banding*, Vol. III, No. 2, April, 1932, pp. 63–65.

FORBUSH, E. H.
1925. Birds of Massachusetts and Other New England States, Vol I, pp. 105–126.

BIRD MALARIA AND MOSQUITO CONTROL

By CARLTON M. HERMAN

Department of Protozoölogy Johns Hopkins University School of Hygiene and Public Health

THE purpose of this paper is to point out that a large percentage of birds in nature are infected with a mosquito-borne malaria, and that this fact presents a phase of a problem of wild-life management that has been overlooked almost entirely.

OCCURRENCE OF PLASMODIUM IN NORTH AMERICAN BIRDS

The causative agent of malaria in birds was discovered in 1885, only five years after it was first recognized in man. Although malaria parasites have been reported from many species of birds throughout the world, very little is as yet known of their prevalence among the avifauna or the effects on the avian population.

In its broadest sense, malaria, which originally meant "bad air", may today be interpreted as applying to the diseases caused by the blood-inhabiting protozoa of the family Plasmodidæ. At least three genera of Plasmodidæ have been reported from birds: *Leucocytozoön*, *Hæmoproteus*, and *Plasmodium*. All these forms live within red blood cells. Only one genus—*Plasmodium*—is known to occur in man. There has been much experimental investigation on the *Plasmodium* of birds which has had direct bearing on the human malady. Mosquito transmission was first worked out with birds in India by Ross in 1898. Most of the recent advances in drug treatment of malaria have been tested first in the laboratory on canaries. Studies of avian *Plasmodium*, however, have been mainly with laboratory birds and have not added greatly to our knowledge of the conditions in the wild bird hosts.

Most protozoölogists recognize only three valid species of *Plasmodium* as occurring in man. However, as has been shown recently by Manwell (1935), there are at least eight valid species prevalent

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