STUDIES OF THE MALARIA PROBLEM IN PORTO RICO

Paper VIII

GRABHAMII IN CERTAIN AREAS ONLY DURING SUMMER AND EARLY FALL

Outside of a few isolated catches in other regions grabhamii was found more or less constantly during the summer and early fall in only a relatively few areas. The main areas are about a small hill called "Paja" in the center of the low lands planted to cane where water was present in ditches all the time. In eight medium-sized ditches in the region grabhamii were more or less constantly found throughout the entire year. The salt content in water deposits in this region varied between .1 and .2 per cent.

EXTENSION OF GRABHAMII BREEDING

Beginning in November, the breading of grabhamii rapidly extended in all directions to other water deposits in these regions, but did not appear in the area nearest the mouth of the river and farthest from Paja until February. The salt content in this latter region was also relatively the highest. Grabhamii larvae never did become very numerous in this region. It was not till the latter part of December and in January that they were found in the majority of stations toward the ocean, 1–2 kilometers away, where the salt content was the highest. General breeding in these latter regions dropped off much more rapidly after February than they did near the original area.

It would seem that the distinction between minimum and maximum seasons of grabhamii breeding are quite marked and that during the unfavorable season the mosquito is found only in certain foci. The region about Paja would seem to be one of them. The hill served as pasture for large herds of oxen and for some horses. The oxen were often taken out at night, however, to a pasture nearer town. It is thus seen that the region furnished both a convenient area for adult mosquitoes and favorable conditions for development of larvae.

Two other apparently definite foci were noted, one in absolutely fresh water and the other in water with a low salt content. The first at the station with number XXVI–C was a medium sized drainage

ditch which carried off water from comparatively high cane land south of town. It was separated from the low lands just considered by ridges of high hills and a distance of 2–3 kilometers. There was a dense population on the hill adjacent to the ditch. During the dry season practically no water flowed through this ditch, but near its mouth it was almost at the same level as the river, so that the water formed stagnant pools.

The channels had been cut deep into the ground and this fact together with abundant grass and other vegetation produced considerable shade.

July was the only month in which no grabhamii larvae were found, but beginning with September, except for an occasional week, they were always found and often in large numbers. Only one week were they found unaccompanied by bimanus.

During heavy rains the water washed through the ditch taking everything with it. After such a rain at the end of August young larvae were found the next week but full-grown larvae were not found till the middle of October, six weeks later. After a heavy washing rain at the end of March, however, within two weeks full-grown larvae were again found. It would certainly seem that summer and early fall was an unfavorable period for this mosquito. During the rainy season grabhamii was found in large numbers in temporary water deposits near this ditch.

The other ditch was XXIV–D which was a small ditch between two small creeks arising from seepage and located to the east of Manatí river and a kilometer from any residence, though within a few yards of pasture land. Cane had not been cut the previous season and there was considerable grass and shade. Grabhamii were constantly found here until March when cane was cut and the ditch cleaned out. Albimanus was always found associated with it and continued breeding after March. Grabhamii breeding was much more abundant in this immediate region during its active period than farther to the east. During wet months, however, it was found widely distributed throughout temporary water deposits.

In two of these foci, at least, there was pasture very near at hand and these were the two main pastures in the region. It is possible that this fact is not without significance as is indicated later in discussion of feeding habits of grabhamii.

REPLACEMENT OF ALBIMANUS BY GRABHAMII IN SAME WATER DEPOSIT

Probably the most interesting of all was to observe the two species of mosquitoes breeding in the same ditch, one at one season and the other at another season. In a few instances grabhamii and albimanus were breeding together all year, but in the majority, albimanus was breeding alone during the summer and early fall. During November grabhamii began to appear in more and more stations and became widespread through December. By December albimanus had passed its high point and was on the decrease. The last week in December, albimanus had decreased and grabhamii increased to such an extent that in two stations (in the area in which grabhamii and been found all year) nothing but grabhamii were found. Throughout January and February the change was more commonly observed, and on into March when the highest number of stations were observed to have nothing but grabhamii during one or more weeks.

A total of 42 stations which had been breeding albimanus larvae at a previous date were found on one or more occasions to have nothing but grabhamii larvae. Twenty-four stations showed the change during January and February, and 30 in March, while albimanus had increased and grabhamii decreased during April, so that only seven stations were found breeding grabhamii which previously had bred albimanus.

The longest period in which only grabhamii were found was twelve weeks, and this was in a small ditch, XIV–D 2, which was in the center of a cane field and was more or less completely covered by grass. Breeding of grabhamii was unusually heavy in this ditch, and when cane was cut in first half of March breeding seemed to be increased for two weeks. The cane leaves started to decay, a foul odor was formed, and in the first part of April only a few larvae were found. A heavy washing rain had just preceded. From then on albimanus appeared but neither species was found in anything but small numbers.

Thus during the summer when cane was low and ditches fairly clean, albimanus was breeding quite heavily. During August and September, as this ditch was in the center of the cane field and as it became more or less covered by grass, the number of albimanus decreased. As the season for grabhamii approached the larvae of this species became numerous until they were the only ones found.

In April grabhamii dropped very low and albimanus reappeared again.

At two others, grabhamii only were found for a period of eight weeks, at two others for seven weeks and in three others for six weeks. These changes took place practically in all types of water deposits in the area but were most common in the drainage ditches. Many of these had been unusually heavy breeders of albimanus previously. The number of stations near the ocean in the water with higher salt content in which this change took place was much lower and grabhamii predominated in these for only very short periods of time. It was also in this region that cane was poorer and growth of grass not so abundant so that shade was less intense. About Paja where grabhamii had always been most abundant, albimanus only continued to breed in numbers along with grabhamii or alone, in the ditches alongside the cane-field roads and these were the ones with less grass and less shade. The change from albimanus to grabhamii did take place, however, in ditches which were quite open.

To attempt to explain these changes until more definite information is at hand is not safe. One might suspect an active antagonism between the two species, but in a region with so many water deposits it would not seem to be of great importance and the two were found breeding together throughout the entire year in several stations. It would seem more likely that other factors associated with the change of seasons act differently on the two mosquitoes so that there are seasons when each is most abundant. Where water deposits are so abundant, chance probably plays a large part in determining whether one water deposit shall receive eggs and another not.

Further corroborative evidence of these seasonal changes is furnished by data obtained in catches of adult mosquitoes.

ANOPHELES VESTITIPENNIS

So far as is known, anopheles albimanus and grabhamii are the only two species previously reported from Porto Rico.

Early in this study a few very young larvae were brought in from several distinct points, whose characteristics did not correspond exactly with those of either grabhamii or albimanus. An unsuccessful attempt was made to hatch them. A little later two full-grown larvae and one pupa were found with similar characteristics but with characters widely different from those of grabhamii or albimanus.

The pupa and one larva hatched into an adult male and female. From the key and descriptions in Howard, Dyar and Knab the mosquito was identified as anopheles vestitipennis. At the time that volume was written nothing was known of the breeding habits of the mosquito nor had the male been described.

Distribution of Breeding.

Nothing was seen of the larva of this mosquito through the summer and early fall. In the last week in October, however, it was found again in fairly large numbers in cane-field ditches XII–DI and C–I and XI–C–D which were all together. This was in the region in which grabhamii had always been more abundant. The larvae were first found (in October) in ditches to the north and east of the Paja hill in the center of the cane fields. The fourth week in November they were found in all but one station in the area adjacent to the north. The week before a few were found in one station in the area beyond this but it was not till the second week in December that they were found generally distributed throughout the stations near the ocean. Extension would thus seem to be to the north across the path of the prevailing winds to a distance of about three kilometers.

In the adjacent area toward the town to the east they were not found until the third week in December. Beyond this adjacent area on the east, however, they did not appear to extend, and except for an occasional catch they were never found in areas V, VI and VII, which lay between the town and the ocean to the west of river. These were the areas farthest to the northeast.

To the south of Paja and toward the populated hill section the larvae were never found except in a few isolated catches.

To the west a few were found late in the season and to the northwest also. It would thus seem that the greatest extension was to the north across the path of prevailing winds.

The water deposits in the areas in which breeding was found and those in which no larvae were found could not be said to differ in any important features. Both grabhamii and albimanus bred both in water deposits in which vestitipennis were found and in which they were not.

It would seem that the mosquito was very scarce during the summer months but that it was breeding lightly in certain foci whose location possibly changed from time to time.

As the season for greatest activity arrived, a focus of importance was present in the area first mentioned (XII). From here they spread mainly in a northerly direction toward the ocean.

To the east of the river, vestitipennis larvae were also found though not widely distributed. It will be remembered that the first larvae of this specie were found in a large bayou (Caño San José) which is located in the southermost portion of this region in which vestitipennis were found. They were first found again in the first part of November simultaneously in a wet-weather ditch near here to the north and in a ditch (XXIV–D) 1–2 kilometers to the northwest, in which grabhamii had been a prominent breeder all year. No extension as definite as on the other side of the river could be demonstrated but observations showed that the larvae were found practically only to the north and west of the region in which they were first found.

Choice of Water Deposit.

With practically only two exceptions there was not a type of water deposit in some representative of which vestitipennis larvae were not found. The river was this exception. They were never found in artificial containers, and breeding did not seem to be heavy in larger drainage ditches and in the bayous.

As with the others, breeding was heaviest in drainage ditches medium and small. In common with grabhamii it was found often in ditches with abundant grass, and large numbers were caught in one ditch XII–CI in which one could almost walk on the grass mat covering the water.

ASSOCIATION OF GRABHAMII AND VESTITIPENNIS

Both mosquitoes started to increase rapidly at about the same time of the year. In two of the ditches in which the larvae were found in October, grabhamii was also present and in the other grabhamii appeared the week later. Vestitipennis did not extend to south as did grabhamii but was abundant if not more so in the areas to the north next to the ocean. In general, however, it was the common thing for the two to be found together. Albimanus of course, in October and November was almost everywhere. The type of water deposit favored by grabhamii, namely, ditches with considerable shade and growth of grass, was also commonly chosen by

vestitipennis. During December and January they were often found breeding together in the absence of albimanus.

Salt Content.

Observations showed breeding in water with approximately the same percentage of sodium chloride as for grabhamii. They were first found in water with per cent around 0.2 per cent but were later found in water with salt as high as 2.5 per cent. Only a few larvae were found here, however. As with grabhamii, fairly heavy breeding was found in water with 0.4 per cent salt and in the areas near the ocean vestitipennis was possibly more often encountered than grabhamii. The concentration of salt certainly would not seem to be a limiting factor to the spread of this larva throughout the water deposits in this region.

SEASON OF MAXIMUM AND MINIMUM BREEDING

As already indicated, the period of minimum production was from sometime before May until the latter part of October, during which period practically no larvae were found. Reference Table XVII shows that at no time were large numbers of larvae caught but that the highest average was reached in December. Relatively large numbers were also found in January. By April, breeding was very light and only found in a few stations. Table XIV shows the average frequency with which vestitipennis was found in the various months. It will be seen that the highest per cent (20) was found with larvae during December, though there was only slight reduction in January.

It would thus seem that the breeding habits of vestitipennis are somewhat between those of albimanus and grabhamii. It reaches its peak between the peaks of the other two and many of its other tendencies are midway between albimanus and grabhamii. It does not seem to be nearly as hardy as the other two, its distribution is very limited, the season of active production very short, and at no time was it present in very large numbers. In the case of this mosquito it is quite evident that during the period of active production the type or character of water deposit was of minor importance in determining presence or absence of breeding. It would seem that other factors determined that the eggs should be distributed in certain regions only.

Distribution Throughout the Island.

Thus far it has only been found at two other places, Dorado, which is on the north coast between Barceloneta and San Juan, and at Fajardo. It was searched for at Ponce but not found. As its period of activity is apparently short and as it does not ever seem to become very abundant, careful search would have to be made during the late fall and early winter before one could say that it is not found at other places on the Island.

TABLE XVII

VESTITIPENNIS LARVA CATCHES BY THE WEEK AND MONTH

Month	Weekly catches				Monthly catches		
	Week	Stations visited	Total larvæ	Lar. per station	Stations visited	Total larvæ	Lar. per station
October	1	48	.....	.....			
	2	48	.....	.....			
	3	36	.....	.....			
	4	44	17	0.4			
	5	31	2	0.07	207	19	0.1
November	1	9	.....	.....			
	2	38	11	0.3			
	3	32	1	.....			
	4	34	30	0.9	113	42	0.4
December	1	44	83	1.9			
	2	49	105	2.1			
	3	47	29	0.6			
	4	31	163	5.3			
	5	39	18	0.5	210	398	1.9
January	1	41	73	1.8			
	2	46	68	1.5			
	3	49	28	0.6			
	4	43	20	0.5	179	189	1.0
February	1	45	25	0.5			
	2	35	5	0.1			
	3	43	21	0.5			
	4	26	15	0.6	149	66	0.4
March	1	44	.....	.....			
	2	45	11	0.2			
	3	42	10	0.2			
	4	31	23	0.7			
	5	46	33	0.7	208	77	0.4
April	1	During April very few Larvæ were found and and these were in scattered stations.					
	2						
	3						
	4						

FIRST PUBLIC-HEALTH CLASS OF THE SCHOOL OF TROPICAL MEDICINE, COURSE OF 1926–27

Seated, left to right: Dr. Antonio Fernós Isern, Assistant Commissioner of Health, instructor; Professor Pedro N. Ortiz, Commissioner of Health; Dr. Gurbar Sing Saut of Amristar Medical College, Punjab, India, student.
Standing: Group of Physicians Enrolled in the Class