CONTRIBUTION TO THE KNOWLEDGE OF THE NATURAL HISTORY OF THE MARINE FISH-PONDS OF BATAVIA

by

Dr. A. L. J. SUNIER,
Head of the Laboratory for Marine Investigations at Batavia.

With 2 Maps, 2 Diagrams, 16 Photographs by the author and 59 Drawings by Raden Mas SUDARSONO.

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show exactly the same type as the sluice-gates of the marine fish-ponds of Arcachon. This is immediately apparent on a comparison of our photo no. 1 (Plate VI) and the schematic figures in VAN SPALL (3) and in DE JAAGER and VAN LAWICK VAN PABST (17), with the illustrations in the text no. 1—3 and the photos 1—6 on plates II — IV in HORNELL (31). Even the net ("la manche") mentioned by HORNELL at the bottom of page 8 can be found again in the little empang sluice-gates, under the Javanese name of "tadah".

§ 2. The Empangs of Batavia.

The data relative to the biology of the empangs which are now at my disposal, I have collected exclusively in the marine fish-ponds in the neighbourhood of Batavia.

The territory of the properly so called Batavian sea-fish-ponds stretches from Slingerland or Oesterbank in the East, as far as slightly to the East of Muara Angke as their Western limit (cf. Map I). When we demarcate this territory to the North by the coast-line of the Java Sea (Bay of Batavia); to the East by a line running from the wayside station Antjol to the sea, at right angles with the railway embankment; to the South by the Trekvaart as far as Pasar Ikan, and further by the Groningsche Weg as far as the Muara Karang, then by the Muara Karang in a southerly direction as far as Telokgong; next to the West by the Western branch of the Krukut Draining Canal towards the North until the Kali Angke is reached, and finally by this river down to the sea, then the area of the territory thus defined, covers, according to the Cadastral Survey Office (Hoofdbureau van het Kadaster), about 1195 hectares or 2950 acres. Within these boundaries the fish-ponds proper, together with the embankments and walls separating the ponds, are stated by the Cadastral Survey Office to occupy circa 730 hectares or 1800 acres. I have myself calculated this area by transferring the fishponds with the embankments and walls between them from the Topographical Service [1]) map (1:50.000, brought down to date, 1 May 1918) on to millimetrepaper, and thus arrive at an area of only 687 hectares or 1700 acres. Including two strips of land, some 50 M. broad, stretching north between the ponds near Pekulitan, I arrrive at about 695 or not yet 700 hectares (= ± 1720 acres).

I have no means of determining with accuracy what part of these 700 hectares represents the real surface of the ponds properly speaking, and how much goes to the embankments and walls in between, for it is recognized that the Topographical Service maps represent these embankments and walls too broad. I think, however, I am not far wrong in estimating the water-surface at not less than $^4/_5$ of these 700 hectares, the remaining $^1/_5$ being taken up by walls and embankments. VAN BREEMEN's estimate (59) (p. 324) putting the water-surface of the fish-ponds comprised between the Muara Karang and the Kali Sunter at 500 hectares or 1230 acres, therefore strikes me as fairly accurate.

[1]) Topographical Service = Topographische Dienst.

VAN BREEN (49) in his schedule of the owners, areas and assessed values (for ground-tax purposes) (verpondingswaarde) of the territories occupied by the fish-ponds north of the capital town of Batavia, between the Muara Angke and the Kali Sunter, computes the total area at 1100 hectares or 2720 acres. This fits well with the calculation of the Cadastral Survey Office above referred to, according to which the area would be 1195 hectares or 2950 acres, as stated above.

Outside this principal zone of marine fish-ponds there is another small group of sea fish-ponds in the neighbourhood of Batavia, west of the Muara Angke, which, inclusive of the intermediate embankments and walls, covers an area of 33 hectares or about 80 acres. Still further west we get to the marine ponds laid out only a few years ago near Kamal, measuring inclusive of embankments and walls circa 55 hectares or 135 acres.

East of Tandjong Priok there is finally a group of marine fish-ponds, originally extending from just east of the first old western harbour-dock of Tandjong Priok as far as Marunda, just east of the Muara Tjilintjing. Of late years, however, the empangs in a large part of the western end of this pond-district have disappeared in connection with the expansion of the harbour towards the East. On the other hand I was informed by people hailing from those parts, that during the last 5 (?) years the entire littoral zone from Marunda to the East as far as Sungei Tawar has been occupied by newly laid out sea-fish-ponds.

The old fish-pond district between Tandjong Priok and Marunda, with which I am personally familiar, at present [1]) extends from Pedjonkoran, situated about $2^1/_2$ K.M. east of the first old western harbour-basin of Tandjong Priok, as far as Marunda, and, according to the Cadastral Survey Office, it covers an area of some 840 hectares or 2075 acres. Within this territory the fish-ponds together with the intermediate embankments and earthen walls occupy 296 hectares or 730 acres according to the Cadastral Survey Office, my own calculation yielding 285 hectares or 704 acres.

The abovementioned ponds, not known to me from personal inspection and situated between Marunda and Sungei Tawar, do not figure in any map. The Kamal fish-ponds are represented only on the latest Topographical Service map. As for the remaining marine fish-ponds in the Residency of Batavia, the Topographical Service maps only show the following additional ones: near Tandjong Kait (in the Tangerang region); near Gagah (near the Hook of Krawang) and near Pakis (at the western boundary of the District (Afdeeling) of Krawang). From fishermen coming from those beaches I learned however, that in the course of the last few years new fish-ponds have been laid out along the Muara Tangerang, facing the isle of Onrust, and along a considerable part of the coast of the District (Afdeeling) of Meester Cornelis, near Muara Gembong, Gagah, Blubuk and Muara Bungin.

1) This was written in the beginning of 1920.

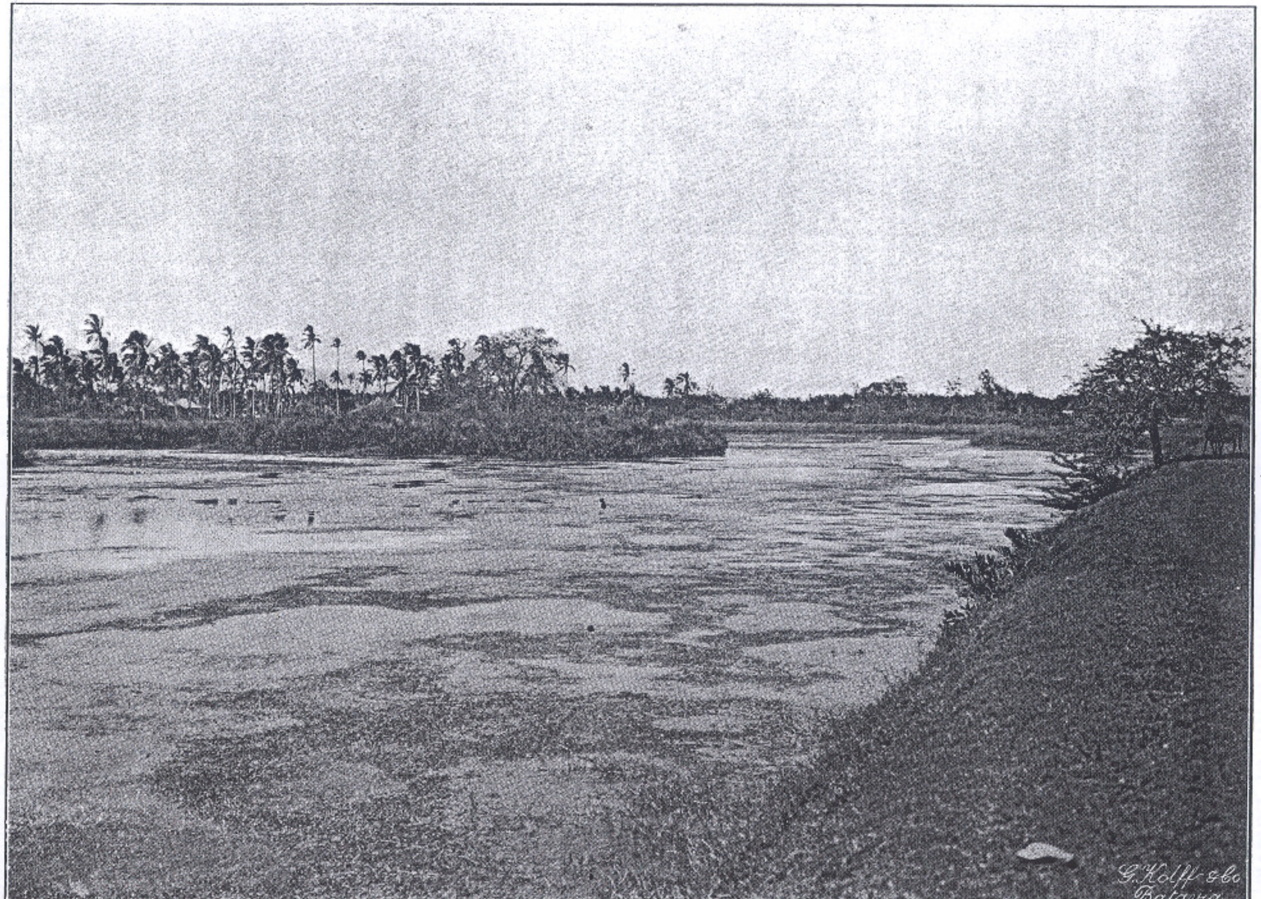

Photo no. 2. (Taken April 16th, 1918). Southern extremity of pond A of Map II taken from the Westside. Submerged vegetation consisting of Najas falciculata R. Br., Ruppia rostellata Koch, Chaetomorpha (herbipolensis Lagerh.?), Oscillatoria and other Schizophyceae. The pond containing little water its bottom has been overgrown by Paspalum distichum L., as may be seen in the foreground of the photo.

The part of the fish-pond district belonging to the Residency of Batavia, between Kamal and Marunda is represented on Map I. All of it, except the eastern part stretching for $1^1/_2$ K. M. from East to West, was prepared from the Topographical Service map (1 : 50.000), brought up to date until May 1st 1918. All the names of localities mentioned in the text below are to be found on Map I.

A little east of the Muara Karang there is a system of marine fish-ponds, belonging to Mr. M. H. Th. Görs, where in early March 1918 MR. VAN BREEMEN and I began the systematic gathering of data concerning the biology of the empangs in connection with the problem of malaria-prevention. A sketch-map of this group of ponds (assessment number (verpondingsnummer) 3238 Batavia) was prepared by my assistant MR. E. C. A. HERBST. It is to be found on Map II. The point marked P on this Map II is marked in the same way on Map I.

Like nearly all the other marine fish-ponds in the neighbourhood of Batavia, Mr. Görs's empangs are rectangular. Their sizes vary, as far as I could make out, between a few square metres (fry-ponds) and $\pm$ 15 bahus [1]). They are nearly always very shallow; when a coolie walks in a sea-fish-pond, the water, even in the deepest places, seldom reaches to his hips, mostly no higher than a little above the knees. Along the margins the ponds are usually deeper than near the centre, as the laying out is begun by digging a ditch all round, which continues to be afterwards more or less regularly dredged. In the construction of large ponds two more ditches are dug, intersecting at right angles, each one connecting the centres of two opposite sides of the rectangular pond. In a number of places the ponds can be made to communicate by means of little sluice-gates (photo no. 1, Plate VI) with one another and with the canals that connect them with the sea.

For further information about the laying out of the ponds the reader is referred to numbers 3, (6,) 17 and 25 of the literature-list.

The embankments and earthen dams or walls between the system of ponds belonging to Mr. Görs are mostly treeless (cf. photos 3, 4, 5 and 13 (Plates VIII, IX, X and XXI)). In a few places only they are planted with coconut palms, as may be seen in photos 6 and 7 (Plates XI and XIII), which however represent another group of ponds, that of Ang Sun Hian near Kampong Fluit.

Along the edges of the ponds, on a level with the surface of the water, there grows very abundantly a grass, *Paspalum distichum* L., belonging to the Paniceae. This grass is a halophyte or salt-indicator, and is recognizable from afar by its blue-green tint. When, as sometimes happens, parts of the fishponds begin to fall dry, those parts are frequently entirely overgrown with *Paspalum distichum* L.. Besides this salt-indicator, the following

[1]) A bahu is $7096^1/_2$ square metres.

plants, frequently occurring along the margins of the ponds, were pointed out to me as halophytes by Mr. C. A. BACKER, the botanist for the Java Flora: the fern *Acrostichum aureum* L.; the Cyperacea *Fimbristylis ferruginea* VAHL; the Verbenacea *Clerodendron inerme* GÄRTNER; the small Composite *Wedelia biflora* D. C.; and the grass *Kerinozoma suraboja* STEUD..

Between the outer ponds of Mr. Görs's group and the sea, there is a belt of mangrove; on the land-side of this belt the ground is often covered with the Aizoidea *Sesuvium portulacastrum* L.. Young sprouts of mangrove trees can be seen in great numbers in the ponds themselves, especially in their shallow central parts.

With some effort one may perceive on photo 4 (Plate IX) in the middle of the pond two young mangrove sprouts as well as a few shallow patches overgrown with *Paspalum distichum* L..

Among the plants occurring with striking frequency in the pond-complex of Mr. Görs I may further mention: *Pluchea indica* LESS.; *Crotalaria striata* D. C.; *Acacia farnesiana* WILLD.; and *Ruellia tuberosa* L.. In the acacias I very often saw nests of weaver-birds.

In the pond-district east of Tandjong Priok the dams between the ponds are mostly planted with *Rhizophora mucronata* LAM., sometimes interspersed with *Rhizophora conjugata* L., as may be seen in photos 8 and 9 (Plates XIV and XV).

CHAPTER II.

The Salinity of the water in the Batavia empangs.

§ 1. Methods of collecting the data.

By the salinity of sea-water we generally understand nowadays, following the lead of S. P. L. SÖRENSEN and MARTIN KNUDSEN, the aggregate weight in grammes of all the salts present in solution in 1000 grammes of sea-water, after the bromine and iodine had been first replaced by chlorine, the carbonates converted into oxydes and the organic matter oxydized.

The figures given below relative to the salinity of the water in the Batavia sea-fish-ponds, were determined by me by means of a series of areometers of Dr. R. KüCHLER of Ilmenau in Thuringia with corresponding thermometers, and of the hydrographic tables of MARTIN KNUDSEN ([16]).

It is well known that even with the greatest precautions it must not be expected that salinity-determinations, made after this method, should possess a higher degree of accuracy than to within 0.1 $^0/_{00}$. In practice however the accuracy is nearly always rather less satisfactory (cf. HELLAND HANSEN ([33])). Thus the average error in salinity-determinations by means of areometers, such as those of KüCHLER, on board the Valdivia amounted to 0.2 $^0/_{00}$, on board the Danish lightships to 0.27 $^0/_{00}$. The largest error in salinity-determinations by means of KüCHLER areometers, found by the investigators of the Scripps Institution in California, amounted to about 0.32 $^0/_{00}$ ([43]).

In 1915 Mr. P. C. VAN KOESVELD, the captain of the Government Investigation Steamer "Brak", and myself determined, with a KüCHLER areometer, the salinity of two samples of sea-water, each divided into 12 portions. The temperatures of the different portions, which had been kept for some time near the hatches of the engine-room, were rather various. As a result, the areometer-readings naturally varied also, so that the observer could not know, already after the first 3 or 4 readings, how high he might beforehand expect the following areometer-readings to be. Now the values found for the salinities varied as follows:

1st sample.	2nd sample.
33.78$^1/_2$ $^0/_{00}$	34.37 $^0/_{00}$
33.78 $^0/_{00}$	34.34 $^0/_{00}$
33.71 $^0/_{00}$	34.32 $^0/_{00}$
33.70$^1/_2$ $^0/_{00}$	34.23 $^0/_{00}$
33.64$^1/_2$ $^0/_{00}$	34.23 $^0/_{00}$
33.62 $^0/_{00}$	34.23 $^0/_{00}$
33.61 $^0/_{00}$	34.22 $^0/_{00}$
33.57$^1/_2$ $^0/_{00}$	34.18 $^0/_{00}$
33.57 $^0/_{00}$	34.17 $^0/_{00}$
33.54 $^0/_{00}$	34.15 $^0/_{00}$
33.53 $^0/_{00}$	34.14 $^0/_{00}$
33.47 $^0/_{00}$	34.12$^1/_2$ $^0/_{00}$

The greatest difference found between the salinity of any two portions of the same sample of sea-water was therefore in the first case 0.315 $^0/_{00}$ and in the second case 0.245 $^0/_{00}$.

Further I found 32.4 $^0/_{00}$, by means of a KüCHLER areometer, for the salinity of one half of a sample of sea-water, which I caused to be taken on the beach just west of the Old Harbour Canal of Batavia, at high tide on October 21st 1918. Mr. K. M. VAN WEEL, our hydrographic assistant, determined by MOHR's titrimetric method the amount of chlorine of the other half of this sample. The salinity, according to the tables of KNUDSEN ([16]), belonging to the amount of chlorine found, was 32.52 $^0/_{00}$. The discrepancy in the results of the two methods as applied to the same sample of sea-water, therefore amounted in this case to 0.12 $^0/_{00}$.

Moreover at the end of 1915 DR. A. WUNDERLICH of the Commercial Laboratory (Handelslaboratorium) at Buitenzorg, determined with a pycnometer the specific gravity of three portions of the same sample of sea-water, which specific gravity was also determined by the captain of our Investigation Steamer and myself by means of a KÜCHLER areometer. The result may be tabulated thus:

	Portion I		Portion II		Portion III	
	Sp. Gr. $\frac{17.5}{17.5}$	Salinity	Sp. Gr. $\frac{17.5}{17.5}$	Salinity	Sp. Gr. $\frac{17.5}{17.5}$	Salinity
Pycnometer	1.02602	34.07 ‰	1.02603	34.08 ‰	1.02604	34.09 ‰
KüCHLER-areometer.	1.02620	34.31 ‰	1.02610	34.17 ‰	1.02610	34.17 ‰

Seeing that, in what follows below, no conclusions are ever drawn on the ground of differences in salinity of less than several units pro mille, it is conclusively shown that for my purposes the areometer-method was sufficiently accurate.

There would even be very little use in trying to determine the salinity of the fish-pond water with greater precision than was observed by me. For the salinity of water-samples drawn at the same time from the same pond, but at different points a few hundred metres apart, displays, as we shall see in what follows, differences of several units pro mille; whilst also, in connection with various factors, to which I will refer again later on (such as the circulation of the water within the pond-system, the admission of salt water or fresh water, rainfall etc.), the salinity of samples collected at the same spot but with a few hours' interval can likewise display great differences.

The salinity of fish-pond water cannot be determined according to the customary simple methods (such as areometer-readings or chlorine titration), with the same accuracy as the salinity of sea-water. In determining the salinity of fish-pond water by means of the areometer method, the areometer-readings will probably be influenced by the large quantities of organic matter dissolved in it, and sometimes also by the presence of suspended detritus and oozy matter [1]). On the other hand when we determine the amount of chlorine and deduce the salinity from this by means of the KNUDSEN tables ([16]), the influence of dissolved organic matter and of particles in suspension will be practically nil.

Furthermore when the water in the fish-pond, whose salinity is being determined, is a mixture of sea-water and of fresh water, admitted from the land-side, such as for instance river-water, the salts dissolved in this fresh water will make their influence felt on the areometer-observations and consequently on the degree of salinity derived from the KNUDSEN tables ([16]).

[1]) Whenever a sample of pond-water contained so many detritus and/or oozy particles that it began to look cloudy, it was strained before proceeding to the areometer-reading.

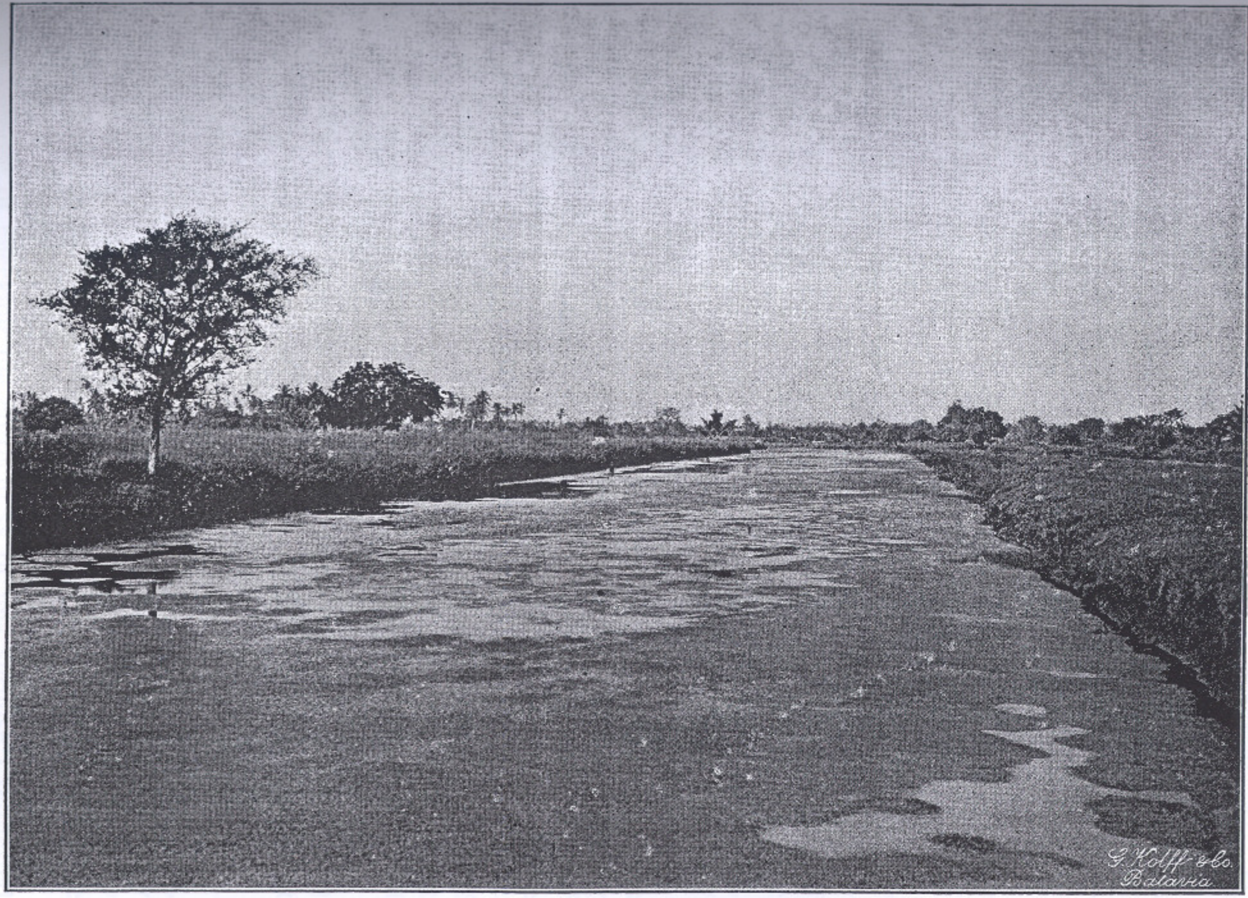

Photo no. 3. (Taken April 27th, 1918). Pond A of Map II taken from the Northern extremity. Submerged vegetation consisting of Chaetomorpha (herbipolensis Lagerh.?), Najas falciculata R. Br., Ruppia rostellata Koch, Oscillatoria and other Schizophyceae.

These salts coming from the fresh water will, however, be included to the extent of only less than 6 % of their real amount in the salinity stated to correspond with the observed amount of chlorine in KNUDSEN's tables ([16]). For, whereas the salts dissolved in the sea-water belong for $88^1/_2$ % to the chlorides, 11 % to the sulphates and only 0.3 % to the carbonates, the salts contained in fresh water on the contrary consist for 60 % of carbonates, 10 % of sulphates and only just over 5 % of chlorides. The proportion of chlorides expressed in the total amount of the salts in fresh water is therefore less than 6 % of the corresponding proportion in sea-water.

However the influence of the salts derived from the fresh water on the salinity of the pond-water cannot be great, as will appear from the following calculation.

A salinity of $7^1/_2$ ‰ would result from the mixture of 1 K. G. of sea-water of a salinity of 30 ‰ with 3 K. G. of distilled water. On mixing one K. G. of sea-water of a salinity of 30 ‰ with three K. G. of river-water, the salinity of which we may put at 0.2 ‰ at the outside, the salinity of the mixture would then work out at $\frac{30 + 3 \times 0.2}{4}$ ‰ $= 7.65$ ‰, assuming that in the admixture no salts disappear from the solution by precipitation.

This difference of 0.15 ‰ in the real salinity of the two mixtures would therefore in this case — apart from possible errors in determining the amount of chlorine — correspond to a difference of not quite 6 % of 0.15 ‰, that is not even 0.009 ‰ of the salinity to be derived from the amount of chlorine observed. On the other hand — again apart from inaccuracies in the areometer and thermometer readings — the difference of 0.15 ‰ would be expressed to practically, though not quite the correct amount in the salinity calculated by the KNUDSEN-tables ([16]) from areometrical and thermometrical observations.

In both cases however the respective differences of 0.009 ‰ and 0.15 ‰, are smaller or at least not greater than the average error that may be expected in applying either method.

In connection with the combined influence of the organic matter dissolved in the pond-water, the oozy and detritus-particles in suspension, and any dissolved salts carried by the fresh water, the figures for the salinity of fish-pond water, determined by areometer and thermometer readings, may however be expected to be generally higher than those resulting from the determination of the amount of chlorine.

For the purpose of checking the correctness of this surmise I requested our hydrographic assistant, Mr. K. M. VAN WEEL, to determine the amount of chlorine in ten samples of fish-pond water, of which I had myself determined the specific gravities by means of areometer and thermometer readings. The result may be tabulated thus:

Samples	Salinity deduced from the amount of chlorine	Salinity determined by thermometer and areometer readings	Difference
1	31.46 ‰	32.13½ ‰	+ 0.67½ ‰
2	29.85 ‰	30.62 ‰	+ 0.77 ‰
3	27.12 ‰	27.88 ‰	+ 0.76 ‰
4	20.86 ‰	21.28 ‰	+ 0.42 ‰
5	21.83 ‰	22.54 ‰	+ 0.71 ‰
6	26.11 ‰	26.65 ‰	+ 0.54 ‰
7	29.29 ‰	29.93 ‰	+ 0.64 ‰
8	27.52 ‰	28.19 ‰	+ 0.67 ‰
9	24.20 ‰	24.51 ‰	+ 0.31 ‰
10	19.02 ‰	19.47 ‰	+ 0.45 ‰
			$\left(+\frac{5.94^1/_2}{10}=\right)$ the average difference = + 0.6 ‰

The salinity of this fish-pond water determined by areometer and thermometer readings in connection with KNUDSEN's tables ([16]) was consequently at least 0.31 ‰, at most 0.77 ‰ and on an average 0.6 ‰ higher than the salinity corresponding in those tables with the amount of chlorine found in it.

That this difference is not owing to imperfect calibration of the areometers used, becomes apparent from the fact that in the comparisons quoted above of the salinity of samples of sea-water, determined first by means of a KüCHLER areometer and secondly with a pycnometer or by chlorine titration, the differences only amounted to 0.12 ‰, 0.24 ‰, 0.09 ‰ and 0.08 ‰ respectively.

I was also able to ascertain that the KüCHLER areometers are on the whole correctly calibrated, by determining the salinity of one and the same sample of pure sea-water kept in a bottle and a little concentrated by evaporation, by means of five different areometers successively; the result being as follows:

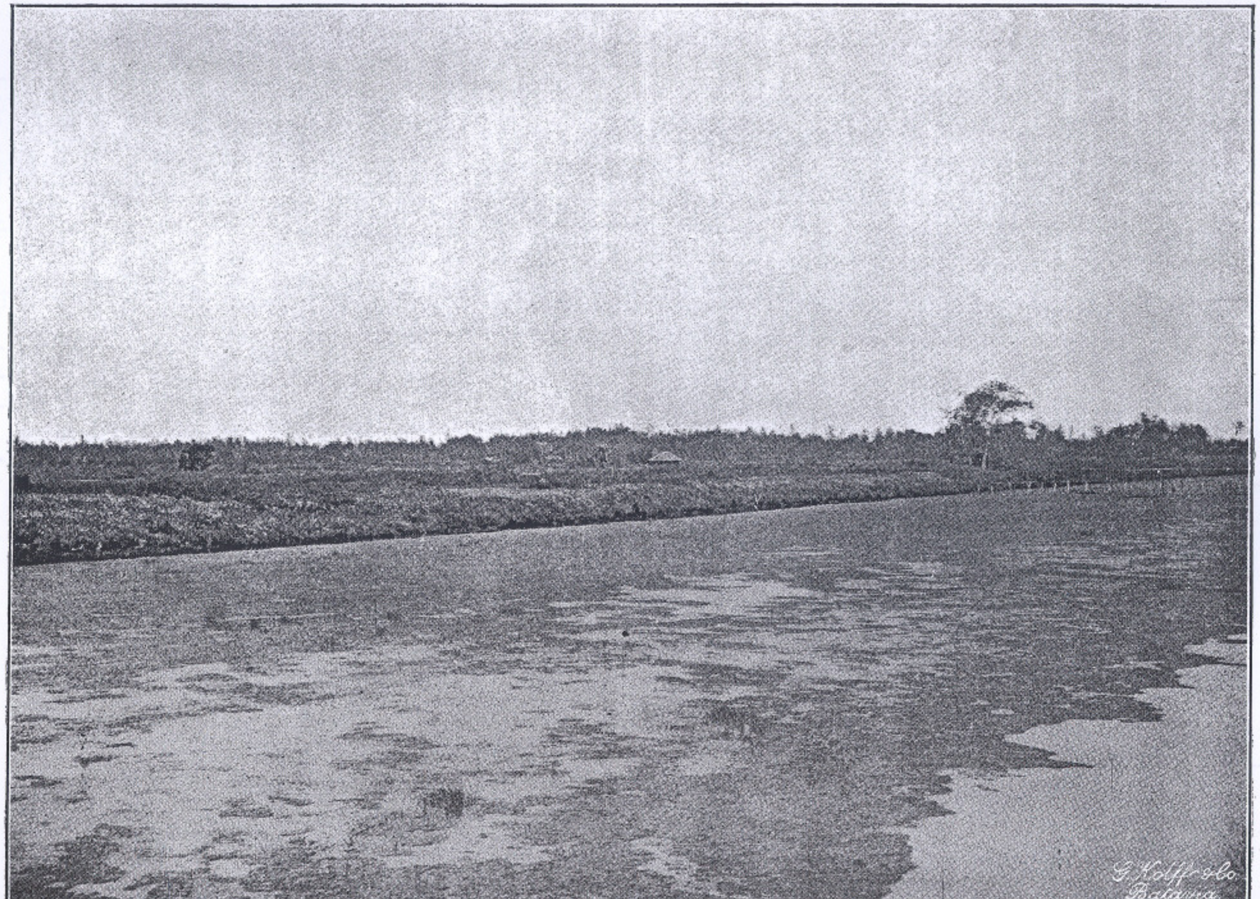

Photo no. 4. (Taken June 29th, 1918). Pond G of Map II, taken from the Westside, from a point situated a little to the North of point 7a on Map II. Submerged vegetation consisting of Chaetomorpha-filaments coated more or less with Chamaesiphonaceae and Chlamydobacteriaceae, of Ruppia rostellata Koch and of Najas falciculata R. Br., all this overgrown by Oscillatoria and other Hormogoneae, by Gloeacapsa etc.. The rounded lights of open water along the margin of the submerged vegetation (in the right-hand lower corner of the photo) are due to the bandeng having eaten away parts of the submerged vegetation in those places.

KüCHLER-areometer No.	areometer-reading	temperature in centigrades	salinity deduced therefrom
4293	23.9^{25}	27.0	34.51^{5} ‰
4291	23.9^{5}	27.0^{25}	34.55^{75} ‰
4294	23.9	27.0^{75}	34.51 ‰
4289	23.9	27.1^{25}	34 54 ‰
4295	23.9	27.1^{75}	34.55 ‰

The first five out of the ten salinities mentioned in the last table but one were determined by means of the areometer no. 4295, the last five by means of the areometer no. 4289.

The areometers of KüCHLER and KNUDSEN's tables ([16]) will only serve for the direct determination of salinities below $\pm$ $41\frac{1}{2}$ ‰. For the sake of simplicity I have determined higher salinities [1]) by diluting one *volume* of fish-pond water with one *volume* of distilled water, and then doubling the salinity found for this mixture. A very few times, when the salinity was extremely high, one volume of this mixture had to be diluted once more with an equal volume of distilled water.

By this method of diluting, the salinity obtained was slightly too high, for the salinity is the total weight in grammes of all the salts dissolved in 1 K.G. of sea-water, not in 1 L..

The approximate value of the error we can compute as follows.

The highest salinity determined by me in this manner amounted to 93.2 ‰.

The result obtained was a salinity of 23.3 ‰ for one volume of pond-water mixed with three volumes of distilled water.

At the moment of diluting and of the areometer reading the temperature of both the fish-pond water and the distilled water was circa 28° C..

The quantities mixed were therefore: 3 volumes of distilled water of 28° C. = 2.98878 weight-units [2]); and 1 volume of fish-pond water of 28° C. and of a salinity to be provisionally put at 93.2 ‰, which is equal to 1.06863 weight-units of pond-water [3]).

The salinity of this mixture was 23.3 ‰.

Therefore in 2.98878 + 1.06863 = 4.05741 weight-units of this mixture there were present 0.094537 weight-units in salts. These salts were got from the 1.06863 weight-units of pond-water; one weight-unit of this pond-water therefore contained 0.0885 weight-units of salts; in other words, the salinity of this fish-pond water was about 88.5 ‰ instead of 92.3 ‰.

[1]) In July and September 1918 some of these high salinities were determined by our hydrographic assitant Mr. K. M. VAN WEEL by halogen titration.

[2]) 1 cM^3 of distilled water at the temperature of 28^0 C. weighs 0.996260 grammes.

[3]) Calculated by means of the formulae given by KNUDSEN ([16]) for S, σ° and σ^{t}.

Now, repeating this calculation and applying the approximate salinity of 88.5 ‰, we arrive at the following:

1 Volume of fish-pond water of 28° C. and of a salinity of 88.5 ‰ = 1.06464 weight-units of fish-pond water. Therefore in 2.98878 + 1.06464 = 4.05342 weight-units of the mixture of three volumes of distilled water and one volume of fish-pond water there were present $\frac{23.3}{1000} \times 4.05342 = 0.094445$ weight-units in salts. These salts had been contained in the 1.06464 weight-units of pond-water. Each weight-unit of this pond-water therefore contained 0.0887 weight-units in salts, or, in other words, the salinity of the pond-water was 88.7 ‰ instead of 93.2 ‰.

The dilution of 1 volume of pond-water with 3 volumes of distilled water occurred but a very few times.

In diluting one volume of fish-pond water with one volume of distilled water the error is smaller. We take the example of a high salinity, viz. 73.4 ‰, found by an areometer-reading on diluting one volume of fish-pond water with one volume of distilled water. The same calculation as the above shows that the real salinity was only 71.5 ‰.

The dilution of one volume of pond water with one volume of distilled water therefore yielded a salinity which, apart from the errors inherent in the areometer-method and its application, was too high by about 1.9 ‰ or less; the dilution of one volume of fish-pond water with three volumes of distilled water yielded a salinity which was too high by about 3.6 ‰ or less.

On determining the salinity of a sample of fish-pond water, first by mixing equal volumes at a temperature of 27.6° C.; and afterwards by mixing equal weights of fish-pond water and distilled water, I found successively 63.9 ‰ and 62.9 ‰.

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§ 2. Discussion of the data collected and elaborated.

From March 5th 1918 onward I determined with fair regularity the salinity of the fish-pond water in a number of places in Mr. Görs's system of ponds. These points are marked on Map II with the digits 1—7, 3a and 7a in the ponds A to G and C' inclusive. All the salinities observed in these places have been collected in Table I.

The letters L, M, z and Z occurring in this Table I under the number of the points of observation, have the following meanings:

L (Land) signifies that the point of observation is situated near the land-boundary of the pond-system; Z (Zee = Sea) signifies that the point of observation is in one of the outer ponds, nearest the sea; M means that the observation point is situated about the middle, or halfway between the land and the sea- boundaries of the pond-system. z Denotes that the point of observation lies nearer the sea than the points marked M, but not so near as a point marked Z.

Now the salinity of the water in an empang is influenced:

1⁰ by the replacing, for the purpose of refreshing the contents of the pond, of part of the stale pond-water which has previously been allowed to flow away at low tide to the sea, or sometimes to some interior water-course on the land side; either
a: by sea-water admitted at high-tide; or
b: by brackish or even fresh water admitted from river- or canal-mouths or similar waters;

2⁰ by water being allowed to pass from one pond into another, in other words by circulation within the pond-system;

3⁰ by the evaporation of the pond-water;

4⁰ by rainfall;

5⁰ exceptionally, by inundation or floods; and

6⁰ probably, by ground-water welling upward.

When on March 5th 1918 I came to the pond-system represented on Map II, the factors mentioned under 4⁰ and 5⁰ had recently made themselves felt. For as a result of the exceptionally heavy rains in February 1918, large areas of the fish-pond district had been flooded here and there by the river-freshets, to such an extent that the bandeng-fish (*Chanos chanos* (FORSK.)) had been able to escape in not a few places. The water in nearly all the ponds represented in Table I was, at that time, shortly after the river-spates, nearly fresh. Only in pond F, quite near the sea, the salinity amounted to 5.5 ⁰/₀₀. This state of things was certainly abnormal.

After early March 1918 the salinity in all those ponds gradually rose. As early as the 19th of March the salinity at all the observation-points but one, was between 5.7 ⁰/₀₀ and 7.9 ⁰/₀₀. Only in pond F situated near the sea it had been possible to replace so much pond-water by sea-water, that the salinity there had risen to 25.8 ⁰/₀₀. Chiefly in connexion with this substitution of sea-water for pond-water, in which process the circulation within the pond-system by means of the little sluice-gates (cf. Map II) in the nature of the case plays a part, the average salinity in the whole of the pond-system continued to increase during March, April and May 1918. While this was going on, the salinity in the inner ponds towards the land continued lowest, that in the outer ponds near the sea being highest.

Local decreases of the salinity, such as took place in the period from April 3rd to May 28th 1918 especially in the outermost ponds, F at point 6, and G at point 7, are bound up with the exchange of water between the ponds in question and those situated more towards the interior. That such decreases of the salinity are unrelated with rainfall is already apparent from the fact, that they do not hold good for the entire pond-system. Moreover it appears from information supplied by the Royal Magnetical and Meteorological Observatory at Weltevreden concerning rain-observations at Tandjong Priok that in the Spring of 1918 after March 4th no rain-showers of importance have fallen in the littoral zone near Batavia.

This circulation continuing within the pond-system, the salinity in all the ponds approaches more and more to the average salinity of the whole system, towards June 15th. It was only in the small fry-ponds C that I met with a higher salinity on June 15th, namely 30.2 ‰. In connexion with the observations of June 27th, when there were observed in these fry-ponds salinities considerably higher than that of sea-water, it is clear that in this salinity of 30.2 ‰ the influence of another factor, viz. evaporation of the pond-water, finds itself noticeably expressed for the first time. That the salinity in the fry-ponds C amounting to 30.2 ‰ on June 15th 1918, cannot be explained from the admission of sea-water alone, is put beyond a doubt by the fact *that, at the same date, in the more seaward ponds, and especially in pond* E at point 5, the salinity was below 30.2 ‰.

After the end of June the influence of evaporation of the pond-water on its salinity becomes increasingly clear. These observations tally with the data supplied by the Royal Magnetical and Meteorological Observatory according to which in 1918 the East-monsoon wind actually began to prevail with force and regularity in the latter half of June.

Consequently, except in the most seaward ponds, F at point 6, an G at point 7, the salinity in all the ponds, already on the 16th of July, exceeds that of the sea-water that can be admitted from the coast. The salinity of this sea-water was on October 21st 1918, towards the end of the dry monsoon: 32.5 ‰; on February 19th 1919, in the wet monsoon, in two different places 26.8 ‰ and 27.2 ‰ respectively. The samples I used for determining these salinities were collected shortly before or after high-tide, at any rate not at a time when water was flowing from the ponds, quite near the coast, at the mouths of the canals used for renewing the water of the fish-ponds.

Now when we consider that, in connection with the evaporation of the pond-water, we see the salinity in all the ponds increase continually after June 1918, until, in September, October and November, the ponds A, B, C, C' and D show salinities of 76.6 ‰; 73.6 ‰; 64.9 ‰; 77.6 ‰ and 75,1 ‰ respectively, and the more seaward ponds E, F, and G at point 7, salinities of 50.2 ‰; 38.4 ‰ and 48.3 ‰, the question arises whether the fish-pond owner is pleased to see these high salinities, and if not, why he does not replace the pond-water by sea-water, which itself had a salinity of 32.5 ‰ only a few days before the maximum salinity of over 76.6 ‰ was reached in pond A.

The truth is that the fish-pond owner is anything but pleased to see the salinity in his ponds rise so high, but that, at any rate in Mr. Görs's pond-system, it is often not possible to replace a sufficient quantity of pond-water by sea-water.

In Diagram I I have traced the maxima and minima for 1918 of the daily highest and lowest water-levels at Tandjong Priok. The data for this diagram are derived from the tidal movement, calculated from the tidal constants by the Royal Magnetical and Meteorological Observatory at Weltevreden. The zero-point of the vertical axis is arbitrary. During the 40 days between February 27th and June 17th, and the 36 days between August 23rd and November 13th, when in 1918 high and low water occurred twice every twenty-four hours at Tandjong Priok, I have constantly taken into account the highest high-water level and the lowest low-water level.

The high and low-water levels on the days between those on which the maxima and minima, represented in Diagram I, occurred, generally speaking do not fall far outside the lines connecting the points traced in Diagram I, as appears from Diagram II in which have been marked the high-water-levels for 36 consecutive days with preponderatingly diurnal tides.

From Diagram I it appears in the first place that in 1918 the difference between high and low water, which varies considerably in the course of the year, was never more than 109 cM. (January 11th) and never less than 19 cM. (August 25th). I presume it will be obvious that the opportunity for replacing pond-water by sea-water will be more favourable, other things being equal, in proportion as the difference between high and low water is greater, and less favourable as this difference diminishes.

A second conclusion to be drawn from Diagram I is that the high-water levels vary more than the low-water levels. The strongest variation is observed in the maxima of the high-water levels (43 cM.), the slightest in the maxima [1]) of the low-water levels (18 cM.).

In connection with the usual level of the bottom of the ponds [2]), it would appear that in the pond-system in question it is actually the differences in the high-water levels that have the greatest influence on the opportunity for replacing pond-water by sea-water.

On the 27th April 1918 Mr. Görs complained that he had been obliged to catch away the fish in pond A of Map II prematurely, in connection with the fact that during the last few months he had been practically unable to admit any sea-water, as the tide refused to rise high enough. I noted in my diary that it was not until between April 27th and May 14th (therefore as may be seen from Diagram I about May 12th) that it proved possible to admit a little more sea-water here. This was also practicable (at least in ponds C, C', D, E, F, and G at point 7) between July 16th and July 30th (therefore as results from Diagram I about the 21st July) when consequently the salinity in the last-mentioned ponds could again be lowered a little.

[1]) By these I mean the low-water levels when the water was highest.

[2]) According to the Service for the improvement of the water-supply and drainage in the capital of Batavia (Dienst voor verbetering der water aan- en afvoer ter hoofdplaats Batavia), the pond-bottom in this part of the fish-pond belt would be mostly at Batavia-level or slightly higher. Batavia-level is approximately equal to the average low-water level of the Java-sea on the coast of the fish-pond region.

Again I could notice that before October 15th, in connection with the fact that, owing to the tides not rising high enough, hardly any water could be admitted from the sea, measures had been taken to admit water from the land-side into the ponds A and B of Map II from the Muara Karang, which caused the salinity of the water in these two ponds to diminish a little after September 24th.

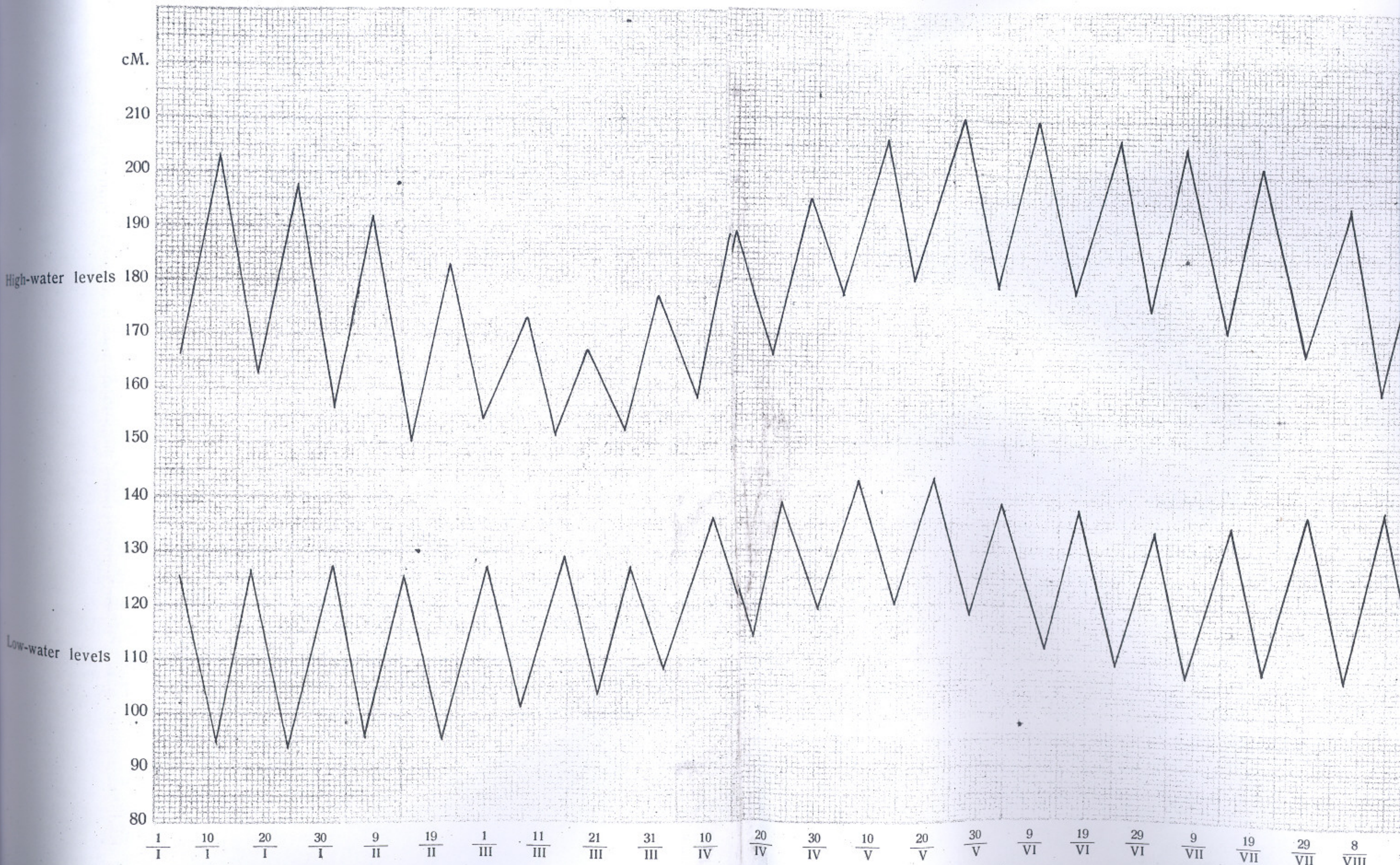
It was not until after October 28th and before November 18th (and therefore as appears from Diagram I about November 6th) that it proved feasible to admit so much sea-water as to lower the salinity considerably in all the ponds except in the small fry-ponds C. The water admitted from the landside from the Muara Karang had a salinity of 32.3 ‰ on November 18th. We may therefore state that in 1918 the flood-tides had to reach at least the level of the spring-tide of November 6th, or slightly more than the level of the spring-tide of April 28th, before considerable quantities of sea-water could be let into Mr. Görs's ponds dealt with here.

The fact that the canals through which the sea-water has to be led to the ponds are but narrow, that they silt up soon, especially their mouths, and that they are not always perhaps dredged out sufficiently and in due time, is of course not without significance for this problem.

As we have already seen, in 1918 the salinity in six ponds reached its maximum between October 28th and November 18th. In pond B of Map II this maximum was reached already before October 15th, in the fry-ponds C only after November 18th.

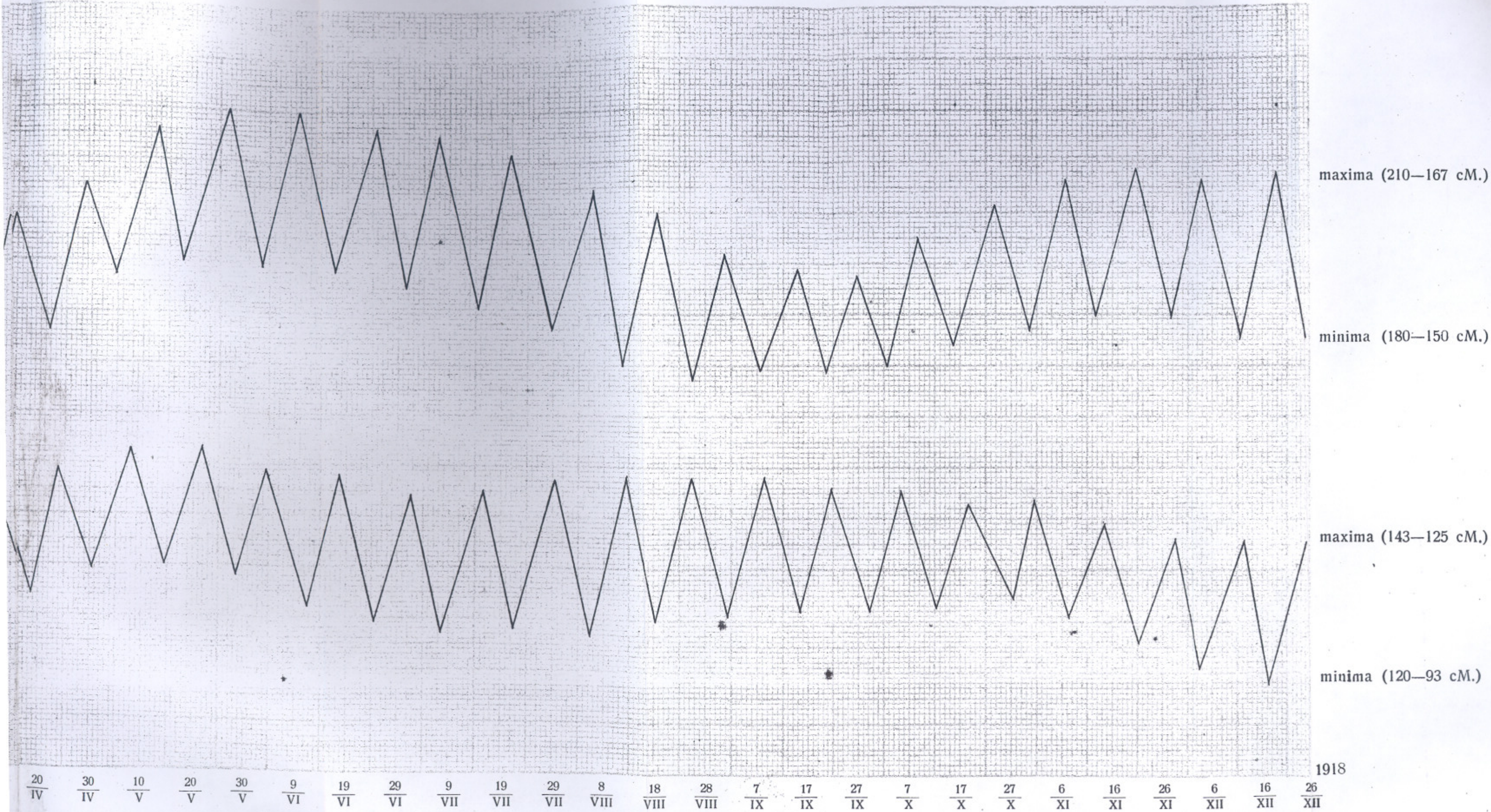
This decrease of the salinities in October, November and also in December 1918, was dependent almost exclusively on the possibility of admitting sea-water towards the end of the year when the floodtides rose higher. The effect of the West-monsoon rains was not noticeable till after February 4th, but then very markedly, as we shall see below from an other series of observations (cf. Table IV). On the 10th of February 1919 the salinity in the most landward ponds was still a little higher than in the ponds nearest the sea. When on April 17 th next I came once more in the pond-system of Mr. Görs, this was no longer the case. So then the last trace of the high salinities that developed during the East-Monsoon (the dry season) of 1918 had disappeared. In 1919 the decrease of the salinities in this pond-system continued at least till July 2nd. On August 12th following, evaporation, under the influence of the regular prevalence of the East-monsoon dry winds, had acted so powerfully again, that in the fry-ponds C and C' salinities were once more found surpassing those of the sea-water on the beach.

Then in October and especially in November 1919 higher salinities of upwards of 40 ‰ to 74.5 ‰ begin to appear again everywhere. I even ascertained the occurrence of salinities as high as 81 ‰ and 93.2 ‰ in the fry-ponds C, on the 20th of October and the 4th of November 1919 respectively. However, at the time when I observed these extreme salinities, these fry-ponds contained no fish.



Maxima and minima of the daily highest and lowest water-levels at Tandjong Priok

DIAGRAM I.



Maxima and minima of the daily highest and lowest water-levels at Tandjong Priok for the year 1918.

From the following it will appear that the influence of evaporation, which is largely dependent on the regular and forcible prevalence of the dry East-monsoon wind, does not, from the nature of the case, act with equal strength every year.

The salinities collected in Table III I calculated from some figures indicating the "amount of NaCl" which were determined some time ago by Dr. B. C. P. JANSEN of the Medical Laboratory (Geneeskundig Laboratorium), Weltevreden, for Mr. VAN BREEMEN.

The place names occurring in Tables II to X refer to that part of the fish-pond belt of Batavia in which the ponds in question are located. All those names are to be found, as has been said before, on Map I.

We can now place side by side the following data, borrowed from the Tables I, III and VI.

Muara Karang				Fluit			Pekulitan		Jaagpad	
1917	1918		1919	1917	1918	1919	1917	1918	1917	1918
2 XI	$^{15}/_{25}$ XI	28 X	4 XI [1]	$^{20}/_{21}$ XI	$^{5}/_{11}$ XII	$^{5}/_{15}$ XI	19 XI	$^{26}/_{30}$ XI	$^{1}/_{6}$ XII	$^{16}/_{30}$ XI
30.5 $^0/_{00}$	36.2-40 $^0/_{00}$	38.4-76.6 $^0/_{00}$	42.9-74.5 $^0/_{00}$	14-27 $^0/_{00}$	44.6-84.6 $^0/_{00}$	36.1-40 $^0/_{00}$	19.5-24 $^0/_{00}$	36.2-40 $^0/_{00}$	10.5-27 $^0/_{00}$	31.1-65.1 $^0/_{00}$
	etc., cf Table I									

Furthermore Table III proves that between October 23rd and December 12th 1917, out of 91 salinity determinations there was no one higher than 32.5 $^0/_{00}$. Therefore contrary to what was observed in 1918 and 1919, the fish-pond water in the autumn of 1917 had at the utmost the same salinity as sea-water. These results agree with the difference in meteorological respects between the East-monsoon of 1917 on one hand, and those of 1918 and 1919 on the other hand (cf. also page 280). For among the data recorded at the Royal Magnetical and Meteorological Observatory, there are indications to show that whilst the very dry East-monsoon of 1918 must have strongly promoted evaporation of the fish-pond water, the extent of the influence of the 1917 East-monsoon on the evaporation must have been a little less than the average.

But also in the years when the general and strong prevalence of the East-monsoon brings about a strong evaporation of the fish-pond water the increase of the salinity in the different ponds shows itself in different degrees, and in some ponds it practically does not manifest itself at all. This appears in the first place from Table II, in which I have collected a few salinities which I gathered on a number of excursions between the regular observations. From this table it may be seen that whereas in many parts of the fish-pond belt the salinity after the middle of July 1918 was

[1]) Moreover, as I stated before, on November 4th 1919 a salinity of 93.2 $^0/_{00}$ was met with in a small fry-pond, which however was not in use at the moment.

higher than that of the sea-water near the coast, it was only in the ponds near Heemraad Oost that on October 22nd 1918 salinities were still to be found of 11.5; 13.5 and 15.4 $^0/_{00}$ respectively, and that on the 24th of December following a salinity of 20.2 $^0/_{00}$ was observed. This is a consequence of the fact that the water of the ponds of Heemraad Oost can be drained away to the mouth of the Gunung Sahari canal, from which mouth water of a low salinity can then be made to flow into the pond again.

The columns of Table VI further demonstrate that in this respect the ponds of Heemraad Oost are not unique. For on putting together the monthly salinity averages mentioned in Table VI, we obtain the following survey:

	Muara Karang	Fluit	Pegan-tungan	Pekulitan	Luar Batang	Jaagpad	Heem-raad	Heem-raad Oost	Antjol
XI '18	53.6 $^0/_{00}$			38.8 $^0/_{00}$	28.5 $^0/_{00}$	46.7 $^0/_{00}$		21.6 $^0/_{00}$	44.0 $^0/$
XII '18	46.0 $^0/_{00}$	58.1 $^0/_{00}$		47.3 $^0/_{00}$	28.0 $^0/_{00}$	33.9 $^0/_{00}$		24.0 $^0/_{00}$	
I '19						39.0 $^0/_{00}$		24.2 $^0/_{00}$	
$^1/_4$ II '19						35.9 $^0/_{00}$			
$^6/_{21}$ II '19						9.5 $^0/_{00}$			
III '19		8.5 $^0/_{00}$		15.7 $^0/_{00}$	21.3 $^0/_{00}$				
IV '19	9.0 $^0/_{00}$	11.1 $^0/_{00}$	16.1 $^0/_{00}$		13.35 $^0/_{00}$	27.7 $^0/_{00}$	11.3 $^0/_{00}$	12.4 $^0/_{00}$	
V '19	10.5 $^0/_{00}$			8.7 $^0/_{00}$		26.7 $^0/_{00}$		10.8 $^0/_{00}$	20.3 $^0/$
VI '19				7.4 $^0/_{00}$		18.1 $^0/_{00}$	16.1 $^0/_{00}$		
VII '19		15.3 $^0/_{00}$	16.7 $^0/_{00}$	14.4 $^0/_{00}$			18.6 $^0/_{00}$		
VIII '19							22.3 $^0/_{00}$	10.55 $^0/_{00}$	
IX '19		38.3 $^0/_{00}$						10.2 $^0/_{00}$	

The above sets forth the fact that in November and December 1918 the salinity of the pond water was everywhere higher, even considerably so than the salinity of the sea-water on the coast, excepting in the ponds of Heemraad Oost and those of Luar Batang. As regards the ponds of Heemraad Oost this phenomenon has already been accounted for by the possibility of admitting water of a low salinity from the mouth of the Gunung Sahari canal. In the same manner also in the ponds of Luar Batang water can be let in not only from the sea, but also from the Old Harbour Canal of Batavia, which communicates by a lock with the Muara (=River mouth) Baru, and from the Muara Baru itself. Finally I also saw at Tjilintjing how the large fish-ponds there (cf. photos 8 and 9, Plates XIV and XV) do not communicate directly with the sea, but with the Kali (= River) Tjilintjing from which more or less brackish water can be admitted.

In the little statistics just given, setting forth the monthly averages of the salinity, there is a large and striking difference between the averages for the ponds situated near Kampong Jaagpad, for the periods of, on the one hand, January and the first 4 days of February, and on the other hand of the rest of February 1919.

Pl. X.

Photo no. 5. (Taken April 27th, 1918). Northern extremity of pond G of Map II taken from the Eastside. Floating masses of Enteromorpha.

The figures relative to the ponds op Kampong Jaagpad set forth in Table VI show that on the first four days of February 1919 the salinity in these ponds, taking the average of 8 cases, amounted to 35.9 $^0/_{00}$. On the 4th even a salinity of 40.1 $^0/_{00}$ was observed. On the 5th however, the salinities observed only amounted to 22.7 $^0/_{00}$ and 13.2 $^0/_{00}$, whilst on the 6th day of the month already a salinity as low as 3.4 $^0/_{00}$ was observed. The explanation of this phenomenon is found in the fact that the first heavy West-monsoon rains in 1919 (according to data supplied by the Royal Magnetical and Meteorological Observatory, Weltevreden) did not come down till the nights of the 4th to 5th, and the 5th to 6th days of February. At 8 o'clock in the morning of February 5th the rain-gauge at Tandjong Priok was tapped of 32 mm. of rain, on the morning of the 6th, also at 8 o'clock, this rain-gauge showed 94 mm.

Whereas therefore the increase of the salinity in the course of the East-monsoon from the nature of the case is a very gradual one, very sudden decreases of the salinity may occur in a few hours during the West-monsoon. No facts have come to my notice tending to show that these fairly sudden and considerable decreases of the salinity should have a lethal effect on the animals living in the empangs. As to the influence of high salinities on the animals' and plants living in the empangs, the reader is referred to Chapters IV to VIII.

In conclusion I must for a moment revert to the statement already made in passing, that the salinity of different samples of water drawn at the same time and from the same pond but at different places situated a few hundred metres apart, may reveal differences of several units pro mille, as appears from the following table :

Date	Salinity at point no. one	Distance between the two points of observation situated within the same pond	Salinity at point no. two	Difference between the two salinities
3 IV '18	14.3 $^0/_{00}$	less than $^3/_4$ KM.	7.5 $^0/_{00}$	6.8 $^0/_{00}$
16 IV '18	16.7 $^0/_{00}$	„ „ $^3/_4$ „	24.7 $^0/_{00}$	8.0 $^0/_{00}$
14 V '18	14.45 $^0/_{00}$	„ „ $^3/_4$ „	21.1 $^0/_{00}$	6.65 $^0/_{00}$
15 VI '18	20.0 $^0/_{00}$	„ „ $^3/_4$ „	24.6 $^0/_{00}$	3.6 $^0/_{00}$
30 VII '18	29.3 $^0/_{00}$	„ „ $^1/_4$ „	35.2 $^0/_{00}$	5.9 $^0/_{00}$
17 IV '19	21.5 $^0/_{00}$	„ „ $^1/_4$ „	18.3 $^0/_{00}$	3.2 $^0/_{00}$
2 VII '19	17.4 $^0/_{00}$	„ „ $^3/_4$ „	13.3 $^0/_{00}$	4.1 $^0/_{00}$
4 XI '19	49.2 $^0/_{00}$	„ „ 1 „	46.5 $^0/_{00}$	2.7 $^0/_{00}$

This phenomenon will most likely be connected in the first place with the different distances of the two points of observation from the places where salt, brackish or fresh water can be admitted and where pond-water can be discharged. Further local differences of insolation or of shelter from the wind may produce differences of salinity. It should be remembered in this connection that diffusion takes place so slowly that it does not make its influence felt very quickly.

CHAPTER III.

The Temperature of the water in the Batavia empangs.

As when starting the investigation I generally determined the salinities on the spot by the direct reading of the areometer and the thermometer, I have at my disposal a number of data concerning the temperature of the fishpond water. The temperatures, which were all observed between 8.30 a. m. and 1.30 p. m., have been arranged in the following table in the order of the days and hours when they were observed.

Temperat

	8.30-8.44 a.m.	8.45-8.59 a.m.	9-9.14 a.m.	9.15-9.29 a.m.	9.30-9.44 a.m.	9.45-9.59 a.m.	10-10.14 a.m.	10.15-10.29 a.m.
15 III '18						29.0	30.0	
19 III '18				28.35	28.4; 28.9	29.4		
3 IV '18	26.5; 26.6	27.4	27.4	27.2	28.1	28.15		
16 IV '18			28.4					
27 IV '18				29.2	29.0	28.9; 29.0	30.4	
14 V '18			28.6	27.8			29.9; 30.1	30.1
28 V '18				28.8	28.0	29.7	30.7	29.7
15 VI '18		25.9; 26.2	26.0			26.6; 26.9; 27.1		28.2
27 VI '18		24.1; 24.9	25.4	24.7	24.4; 25.4; 27.2		27.1	26.9
2 VII '18								
16 VII '18		26.7	26.4; 26.6; 26.7	26.5; 26.7	28.8	27.3	28.6	
25 VII '18								28.0
30 VII '18						27.5	27.7	27.3; 29.2
6 IX '18						28.5; 28.7; 29.8		30.0
24 IX '18							28.9; 29.3	
15 X '18							31.7; 32.3	31.8; 33.5
28 X '18						28.5; 28.8	29.8; 30.2; 30.8	29.1
18 XI '18						29.7; 32.1	29.9; 32.1	31.0
17 IV '19				29.3	28.9; 30.9	28.0; 28.2; 29.3	29.0; 29.7	
2 VII '19		27.7	27.7; 27.8	28.1	27.2	28.6		28.1

For the purpose of drawing conclusions, however, these figures would also have to be arranged according to those peculiarities of the places of observation which may affect the temperature of the water; such as e.g. the depth of the pond, absence or presence of shade, algal growth, absence or presence of larger aquatic plants etc. etc.. For this purpose however the materials are too scant, which is due to the fact that there was no reason for me to make special temperature observations as such.

The table, however, proves that in 162 cases the temperatures observed between 8.30 a. m. and 1.30 p. m, in the months of March to July and September to November 1918, and further in April and July 1919, ranged

tigrades (degrees Celsius).

-10.59 a.m.	11-11.14 a.m.	11.15-11.29 a.m.	11.30-11.44 a.m.	11.45-11.59 a.m.	12M-12.14 p.m.	12.15-12.29 p.m.	12.30-12.44 p.m.	12.45-12.59 p.m.	1-1.14 p.m.	1.15-1.30 p.m.	
		32.0; 32.0	32.5								15 III '18
.7			33.9	31.1						34.9; 35.3; 38.7	19 III '18
	31.7				31.3	30.2					3 IV '18
; 32.7			31.7; 32.7	34.1			31.1				16 IV '18
3.2											27 IV '18
9.8									35.1; 37.1		14 V '18
	30.2										28 V '18
											15 VI '18
	28.9										27 VI '18
			29.2; 30.2			31.1			30.3		2 VII '18
29.9	29.2; 29.3										16 VII '18
											25 VII '18
	31.3										30 VII '18
		31.4	30.1								6 IX '18
	29.9; 30.1										24 IX '18
			32.7				36.1				15 X '18
29.1					31.2; 31.3	32.4	32.0		32.5	34.4	28 X '18
.1; 31.1	31.4					32.2					18 XI '18
											17 IV '19
30.6	29.2										2 VII '19

between 24°.1 C. (27 VI '18; 8.50 a. m) and 38°.7 C. (19 III '18; 1.30 p. m.). The latter temperature however was observed in a little deserted pond, only a few square metres in extent, hardly more than one foot deep, and for the greater part choked with *Najas falciculata* R. BR..

The two other temperatures also observed on March 19th 1918, at 1.30 p. m., and those observed on May 14th 1918, at 1 p. m., and on October 28th 1918, at 1.20 p. m., of respectively 34°.9 and 35°.3; 35°.1 and 37°.1; and in the third place 34°.4 C., all refer to fairly normal ponds that were in use, near Heemraad Oost, which are not, however, among the largest and deepest ponds in the Batavia fish-pond belt. The temperature of 36.1 degrees Celsius, observed on October 15th 1918, at half past twelve in the afternoon belongs also to a normal pond near Luar Batang on the Muara Baru.

CHAPTER IV.

The submerged vegetation in the Batavia empangs.

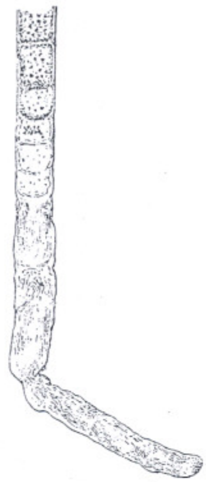


Fig. 1. Extremity of a Chaetomorpha-filament from the Batavia empangs with rhizoids (?) × 70.

The photos no. 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII) present a picture of the submerged vegetation reaching up to just beneath the surface of the water and developing spontaneously in the Batavia empangs; as we shall see in Chapter V this vegetation serves for food to the bandeng-fish (*Chanos chanos* (FORSK.)) reared in those empangs. Of the plant-species composing this vegetation the principal one is a filamentous alga usually called "lumut kain" ("rag-alga") or "lumut sutra" ("silk-alga") at Batavia.

Dr. W. M. DOCTERS VAN LEEUWEN, the Director of the Botanical Gardens at Buitenzorg, sent a sample of this lumut sutra for determination to Mrs. A. WEBER—VAN BOSSE. The alga proved to be a species of *Chaetomorpha* [1]) (Chlorophyceae, Siphonocladiales, Cladophoraceae), and according to Mrs. WEBER in all probability *Chaetomorpha herbipolensis* LAGERH.. Mrs. WEBER however, added that not having seen a basal cell with which the filaments are fixed to the substratum

[1]) Personally I had taken lumut kain to be an alga belonging to the Chaetophorales (= Confervales) and more particularly to the Ulotrichaceae.

Dr. CH. BERNARD to whom I forwarded a sample of lumut kain was inclined to share this view, adding however, that he had found that of the known Ulotrichaceae, none but the genus Microspora can possess such netlike chromatophores (as visible in the lumut kain) but that he was unable to assert whether the lumut kain ought really to be looked upon as a Microspora species. In connection herewith, when meaning lumut kain, I used (56) to refer to it as the "Microsporalike alga".

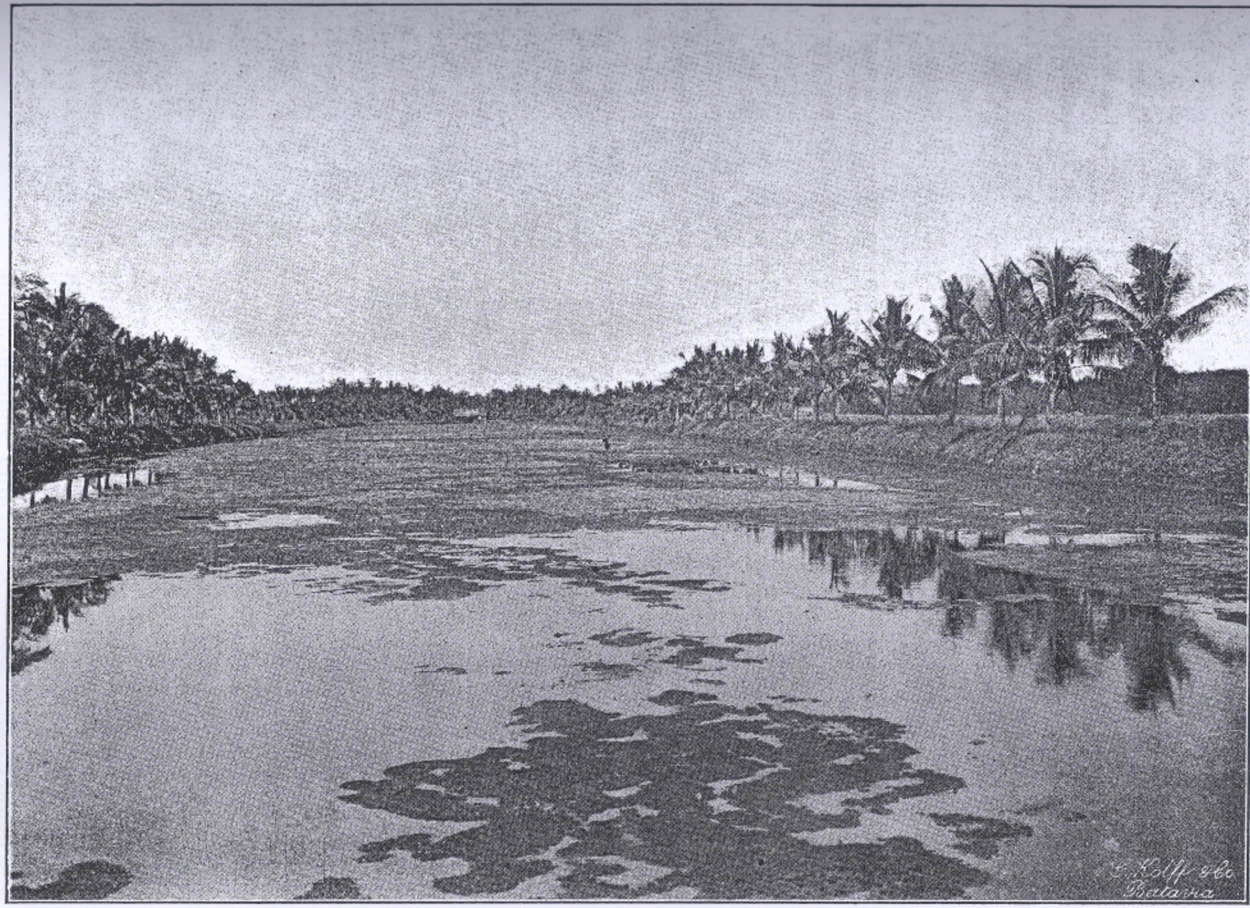


Photo no. 6. (Taken June 29th, 1918). Pond of Ang Sun Hian near Kampong Fluit (cf. Map I), taken from the Northern extremity. Submerged vegetation consisting chiefly of Chaetomorpha (herbipolensis Lagerh.?) and Ruppia rostellata Koch overgrown by Oscillatoria and other Schizophyceae. Embankments planted with coconut palms.

when young, and not having had the opportunity to watch the escaping of the zoöspores, it was not impossible that the alga might belong to a different species.

As to the zoöspores, on October 15th 1918 I came upon an empang of Mr. Görs's near Muara Karang which was chokeful of *Chaetomorpha* and whose water, then possessing a salinity of 56.2 $^{0}/_{00}$ looked dark green as a result of the presence of large numbers of zoöspores with four cilia. Now as according to ENGLER and PRANTL ([13]) *Chaetomorpha* produces zoöspores with 4 cilia, it is probable that in this pond I was really dealing with *Chaetomorpha* zoöspores.

It is well-known that in their youth the *Chaetomorpha*-species are anchored to some substratum or other.

The lumut kain indeed, regularly begins to grow from the bottom of the empang or from some other fixed substratum.

In fig. 1 is pictured the extremity of a *Chaetomorpha*-filament from one of the Batavia empangs; the cells of the extremity have evidently become differentiated into rhizoids with which the young alga-thread is fixed to the substratum. The length of the cells and the thickness of the cell-wall vary considerably. For the difference in length of the cells see figs. 2 and 3. As to the thickness of the cell-wall, I received the impression that it generally increases in proportion as the alga lives in water of a higher salinity. I have not, however, collected any statistical data bearing on this point, and can therefore not guarantee the correctness of this impression. It is well-known that the one cell thick filaments of *Chaetomorpha* are not branched.

Fig. 2 Portions of two Chaetomorpha-filaments from the Batavia empangs. × 130.

As may be readily understood, from figs. 1, 2 and 3 it does not appear in a sufficient manner, that the chromatophore has the shape of a hollow cylinder. The figures show that this chromatophore contains a large number of pyrenoids. It has a number of openings by which it may assume a net-like character. Small fragments of the chromatophore may even become entirely detached.

Fig. 3 Portion of a Chaetomorpha-filament from the Batavia empangs. × 65.

As said before, in the Batavia empangs *Chaetomorpha* is very common and generally begins to develop from the bottom of the pond or from some other fixed substratum. I could clearly observe this among other cases on March 19th 1918; on

October 28th 1918, and on April 17th 1919. The masses of algae, however, very soon grow upwards until they reach up to just beneath the surface of the water. They may also sometimes get loose from the pond-bottom, when they come floating up against the surface of the water. Together with the other water-plants to be mentioned below they may fill up large parts of the ponds, as shown in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII).

Chaetomorpha masses are not seldom seen to emerge just above the surface of the water, the filaments appearing above the water then not being of a lovely green, but of a lemon-yellow hue. I very often had the impression that this rising above the surface was connected with the producton of oxygen bij the masses of *Chaetomorpha*, which would seem to be lifted up bij the numerous little gas-bubbles occurring between the filaments.

On the submerged vegetation reaching up to just under the surface of the water, consisting of *Chaetomorpha* and of the other plants to be named below, there lives often quite a complex flora of smaller forms in the Batavia empangs, partly overgrowing or coating the separate *Chaetomorpha* filaments, partly extending over the entire submerged vegetation. Among these forms Schizophyta play a very important part.

There are, to begin with, forms like *Oscillatoria*, *Lyngbya* and *Nostoc*, frequently overgrowing the entire submerged vegetation with a filmy layer. Sometimes the upper side of the submerged vegetation is coloured red by the presence of a Chroöcoccacea, which I think ought to be looked upon as a *Gloeocapsa* species (perhaps *Gloeocapsa sanguinea* ENGLER & PRANTL ([15])). This *Gloeocapsa* I invariably met with on quite old submerged vegetations.

Among the forms that grow round the separate *Chaetomorpha*-filaments I think I have perceived in the first place Chamaesiphonaceae (ENGLER & PRANTL ([15])), Chlamidobacteriaceae (*Streptothrix*-like forms) and also Diatomaceae. Dr. CH. BERNARD further informed me that on filaments of a sample of *Chaetomorpha* which I sent to him, he had found a Mycoideacea. To a specialist familiar with the systematics of these forms the coated (or overgrown) *Chaetomorpha*-filaments would present ample scope for investigation. As a result of this coating the old *Chaetomorpha*-filaments are often of a dark brown or nearly black. Some further details concerning the coating or overgrowing of the *Chaetomorpha*-filaments are to be met with in the observation-table. (Table IV).

With the forms that overgrow the submerged vegetation are immediately related the forms collectively referred to at Batavia by the name of „tay-ayer" (= "water turd"). This „tay-ayer"-vegetation develops at the bottom of the empangs, especially when this bottom has been laid dry for a couple of days. [1])

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[1]) Confer also Chapter V.

VAN KAMPEN ([25]) says that "tay-ayer" is "a dirty-grey (vuilgrauw) mass consisting of a blue-alga (*Oscillaria* sp.)". Undoubtedly Blue-algae (Cyanophyceae = Schizophyceae) and especially *Oscillatoria*-like forms constitute the main part of "tay-ayer". Beside these latter, however, I also found *Lyngbya-*, *Spirulina-*, *Microcoleus-* and *Nostoc*-like forms in "tay-ayer"-samples.

Among these Schizophyceae-filaments are often found a great many small Nematodes (Enoplidae or Anguillulidae (?)), frequently also Amoebae. Diatomaceae also occur plentifully in tay-ayer, chiefly *Pleurosigma*-like forms, in the second place also forms like *Amphipleura*, *Toxonidea* and many others. Samples of tay-ayer also often contain Bacteria. The Schizophyceae-threads of the tay-ayer may in their turn be overgrown or coated with forms like Chamaesiphonaceae and Chlamydobacteriaceae.

In conclusion I must mention that on March 15th 1918 I came upon certain *Closterium*-like forms, or at any rate Desmidiaceae, in a sample of tay-ayer drawn from a pond the water of which at that moment had a salinity varying between 15.5 $^0/_{00}$ and 21 $^0/_{00}$. As far as I am aware the salinities mentioned are very high for Desmidiaceae.

Chaetomorpha I found in the Batavia empangs at all the salinities observed in them, varying as stated above between less than 3.5 $^0/_{00}$ and 84.6 $^0/_{00}$. [1]) In my diary I find an entry to the effect that on March 15th 1918 I observed, a.o. in Mr. Görs's ponds A and B (cf. Map II), *Chaetomorpha* in water that was almost fresh or at all events had a salinity below $3^1/_2$ $^0/_{00}$. On the other hand it may be seen in Table IV (observation-table) how on December 6th 1918 in an empang near Kampong Fluit, the water in which then possessed a salinity of 84.6 $^0/_{00}$ I came upon a large quantity of floating algae, which proved to consist not only of "dying, yellow, coated", but also of "fresh green *Chaetomorpha*-filaments with very little coating", together with *Chaetomorpha*-filaments in intermediate stages.

In the latter table, for December 7th, 1918, there is also an entry concerning a pond near Kampong Fluit, with a salinity of 70.7 $^0/_{00}$, where I met with "fine, mostly rather dark-green *Chaetomorpha*, slightly coated to more or less heavily coated; also dead Chaetomorpha clad with a red-brown coating". From the foregoing it therefore results that fair *Chaetomorpha*-filaments evidently in good condition still occur in water possessing a salinity as high as 70.7 $^0/_{00}$ or even 84.6 $^0/_{00}$.

Another note in my diary states how on October 28st 1918 I could observe that in Mr. Görs's pond E (cf. Map II) into which some new seawater had recently been admitted and where the salinity was then some 50 $^0/_{00}$, a *Chaetomorpha* vegetation was beginning to develop.

From the numerous data in my diary and in the observation-table (Table IV) I am therefore unable to infer a definite influence of the salinity

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[1]) Though I observed on the 4th of November 1919 in the fry-ponds C′ (cf. Map II) a salinity of 93.2 $^0/_{00}$, the fry-pond whose water showed this high salinity, at that time contained neither fish nor algae.

(within the limits under observation: less than $3^1/_2\,^0/_{00} - 84.6\,^0/_{00}$) on the occurrence of *Chaetomorpha*.

Still, in the Batavia empangs the large masses of *Chaetomorpha* and speaking more generally the whole submerged vegetation develop most luxuriantly in spring at the end of the West-monsoon, i.e. at a period when the salinities of the fish-pond water (except perhaps in a very abnormal year) are always lower than $30\,^0/_{00}$, usually below $20\,^0/_{00}$, occasionally even below $5\,^0/_{00}$.

But it cannot, on the strength of this, be assumed with certainty that low salinity is actually the factor that favours the strong development of *Chaetomarpha* masses and of the submerged vegetation in general. For during the West-monsoon also the salinities are low or even very low, and yet the most luxuriant development of the masses of *Chaetomorpha* and of the submerged vegetation in general takes place, not during but after a pronounced West-monsoon. What may be of importance in this connection is the fact that during the West-monsoon the heavy falls of rain render conditions in the ponds rather unstable, in other words that during a pronounced West-monsoon the water in the fish-ponds is very little in repose.

There are however, a few more indications in connection with which it seems probable that a luxuriant development of the submerged vegetation is favoured by salinities of say below $30\,^0/_{00}$ or little higher than $25\,^0/_{00}$. The ponds mentioned in Chapter II to which water of low salinity can nearly always be admitted, such as those near Heemraad-Oost, are indeed on the whole distinguished by a more continuous luxuriant development of the submerged vegetation.

Besides *Chaetomorpha*, as the chief component of the submerged vegetation reaching up to just beneath the surface of the water in the Batavia empangs, one of the further important components to be mentioned in the first place is *Ruppia rostellata* KOCH [1]), a brackish and salt-water cosmopolitan belonging to the Potamogetonaceae.

Figure 4 (Plate XII) represents part of a *Ruppia rostellata* plant from one of the Batavia empangs. In Malay *Ruppia* is mostly called simply "rumput" (= grass) at Batavia. The branches and leaves of the *Ruppia* in the Batavia empangs mostly float in a level just beneath and against the surface of the water, in curved lines that remind the spectator somewhat of hair-vortices.

Ruppia rostellata may be found nearly everywhere and at any time in the Batavia empangs. I usually found rather small patches of *Ruppia* of a metre or even less across, here and there, often amid the masses of *Chaetomorpha*, frequently also in places where the water was otherwise open. Very occasionally I observed how a somewhat larger part of a pond was occupied practically entirely by a *Ruppia* growth. Thus on

[1]) Determined by the Botanist for the Java-flora Mr. C. A. BACKER.

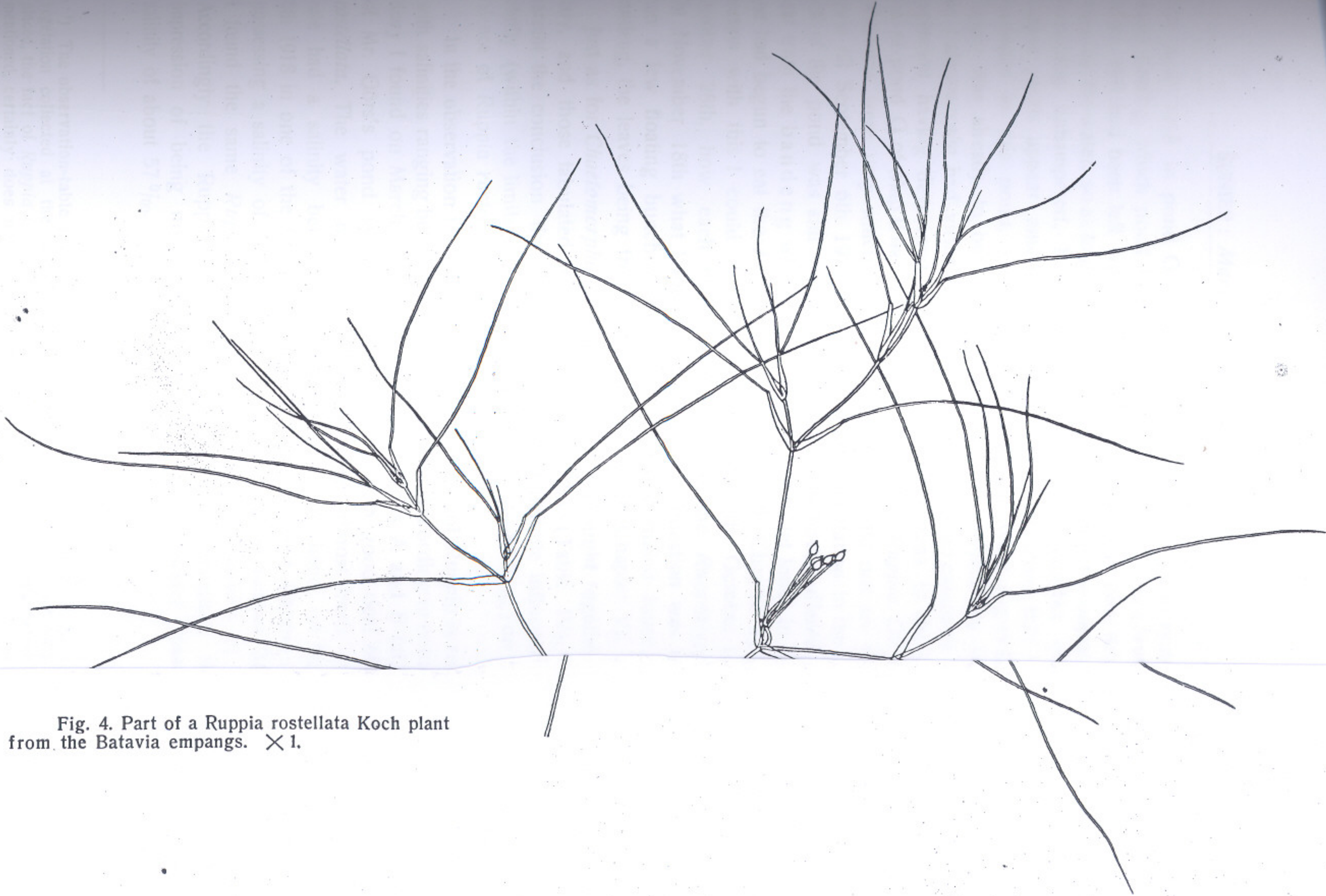

Fig. 4. Part of a Ruppia rostellata Koch plant from the Batavia empangs. ×1.

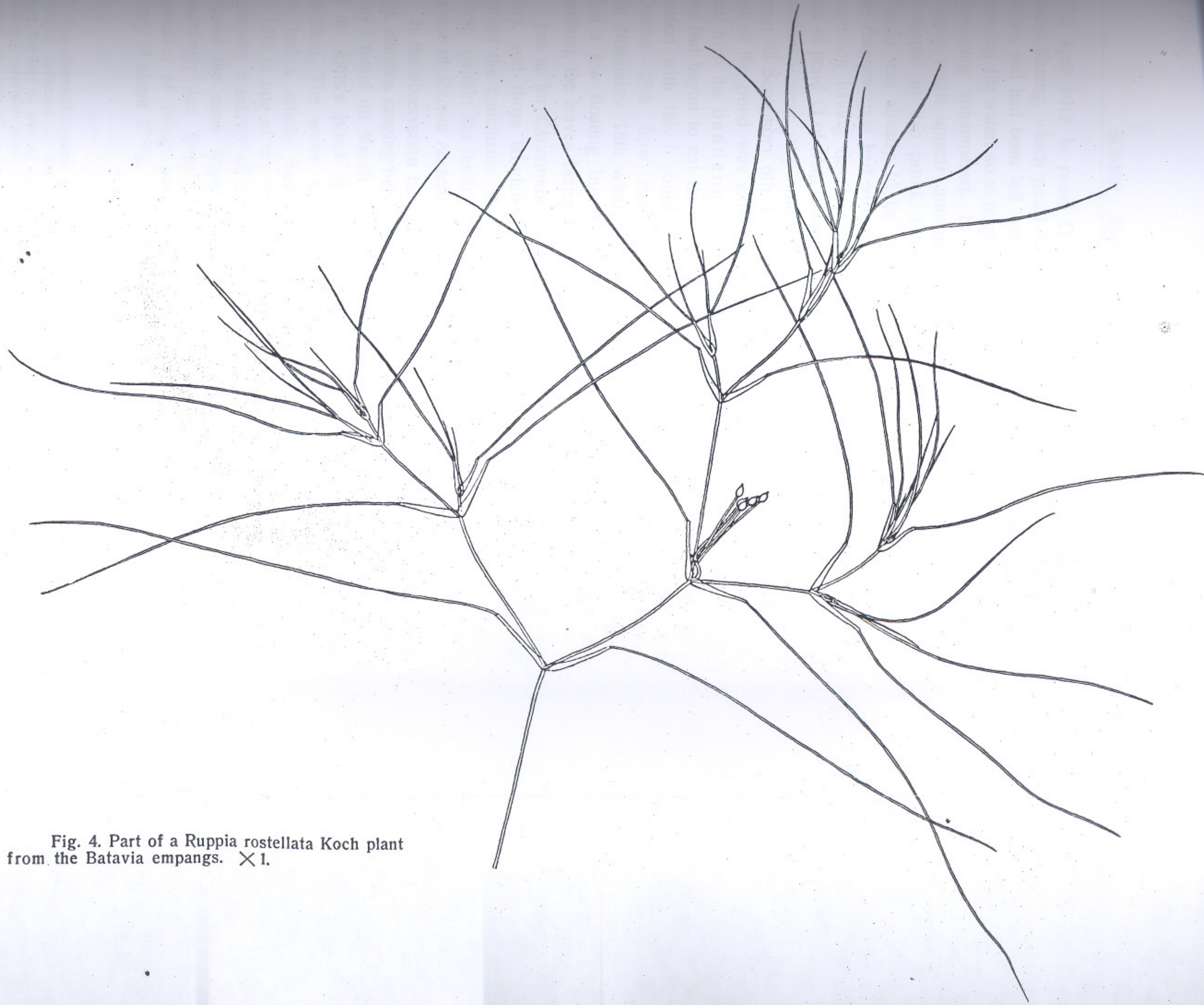

Fig. 4. Part of a Ruppia rostellata Koch plant from the Batavia empangs. ×1.

27th April 1918 in pond G (cf. Map II) of Mr. Görs's pond-system near Muara Karang, which pond had been entirely cleared of fish a few months before, and had been left without bandeng for some time after thoroughly renewing the water, so as to give the submerged vegetation the opportunity of developing unhampered, I was able to observe a number of young *Ruppia* plants appear among an *Enteromorpha*-vegetation that had first developed in this pond. On the 14th of May following a good deal of *Ruppia* was already to be seen among the *Enteromorpha*. By June 15th the *Enteromorpha* had virtually disappeared altogether, an extensive *Ruppia*-vegetation having developed. On July 16th large areas in the northern half of pond G of Map II had been entirely occupied by *Ruppia*. On July 30th conditions were very much the same. After that I did not see the pond again till September 6th 1918, when the *Ruppia*-vegetation in the northern half of the pond was still present, but appeared to have suffered a good deal from the bandeng which had meanwhile been let loose in the pond and had begun to eat the *Ruppia*-leaves (for this cf. Chapter V). In connection with this I could observe on September 24th, October 15th, and October 28th, how each time less remained of the *Ruppia*-vegetation. On November 18th what I found in the pond in question was no more than a few floating bunches of *Ruppia*, probably pulled loose by the bandeng, the leaves being frequently eaten away (cf. Chapter V).

Just as for *Chaetomorpha*, the numerous data brought together in my diary, and those tabulated in the observation table (Table IV), do not warrant the conclusion that there should exist a definite influence of the salinity (within the limits observed: less than $3^1/_2$ ‰—84.6 ‰) on the prevalence of *Ruppia rostellata*.

In the observation table (Table IV) the presence of *Ruppia* is reported [1]) with salinities ranging between 6.0 ‰ and 42.4 ‰. According to entries in my diary I found on March 5th 1918, a.o. in the ponds A and B (cf. Map II) of Mr. Görs's pond system near Muara Karang, a good deal of *Ruppia rostellata*. The water in those ponds was then almost fresh, or at any rate had a salinity below $3^1/_2$ ‰. On the other hand, on September 6th 1918 in one of the fry-ponds C (cf. Map II) I found *Ruppia* in water possessing a salinity of 57.9 ‰. Eighteen days later, September 24th 1918, I found the same *Ruppia* in the same pond at a salinity of 56.9 ‰. Accordingly the Ruppia plants which at both observations made an impression of being normal, had lived 18 days in water possessing a salinity of about 57 ‰.

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[1]) The observation-table giving only the composition of a sample of the submerged vegetation collected at the place where the mosquito-nets (cf. Chapter VII) had been placed, the fact of *Ruppia* or another component of the submerged vegetation not being mentioned, certainly does not mean that that component did not occur in the pond observed, nor even at or near the place of observation.

My diary states the presence of *Ruppia rostellata* in one of the ponds of the group represented in Map II, when the salinities were as follows, observed on the days mentioned:

< 3½ ‰	5 III '18
5.9 ‰	15 III '18
9.3 ‰	3 IV '18
10.6 ‰	3 IV '18
10.9 ‰	16 IV '18
12.1 ‰	3 IV '18
12.4 ‰	3 IV '18
13.0 ‰	27 IV '18
13.1 ‰	16 IV '18
13.6 ‰	2 VII '19
14.0 ‰	16 IV '18
16.7 ‰	16 IV '18
16.7 ‰	2 VII '19
17.4 ‰	2 VII '19
18.1 ‰	17 IV '19
18.3 ‰	17 IV '19
21.5 ‰	17 IV '19
21.6 ‰	2 VII '18
23.6 ‰	27 IV '18
25.3 ‰	2 VII '18
26.4 ‰	15 VI '18
26.4 ‰	27 VI '18
27.6 ‰	29 VI '18
27.8 ‰	27 VI '18
31.7 ‰	16 VII '18
31.7 ‰	6 IX '18
34.0 ‰	27 VI '18
36.5 ‰	16 VII '18
36.6 ‰	16 VII '18
37.7 ‰	12 VIII '19
39.3 ‰	18 XI '18
40.2 ‰	16 VII '18
42.4 ‰	30 VII '18
42.4 ‰	24 IX '18
45.8 ‰	15 X '18
47.8 ‰	16 VII '18
50.0 ‰	16 VII '18
53.4 ‰	6 IX '18
56.9 ‰	24 IX '18
57.9 ‰	6 IX '18

PL. XIII.

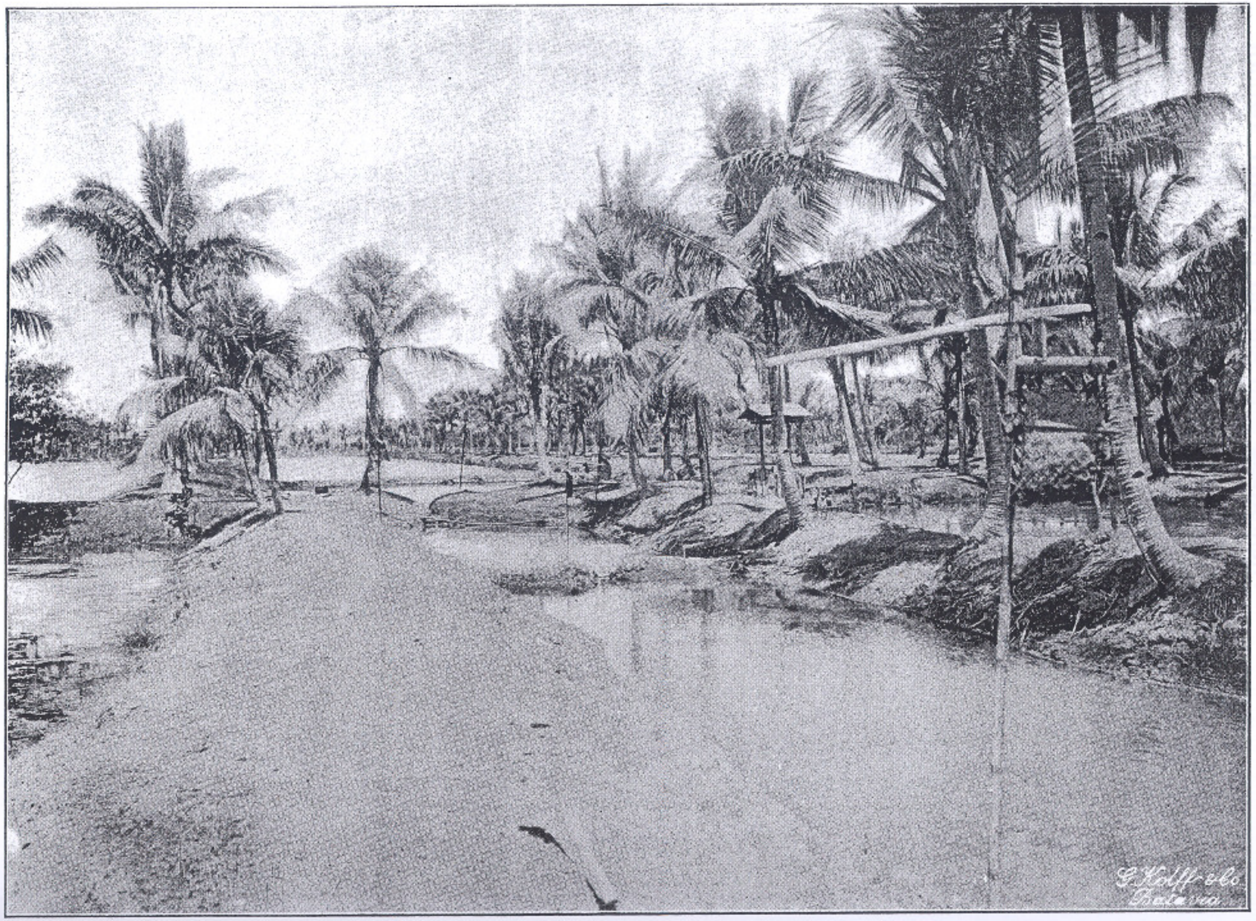

Photo no. 7. (Taken in 1915). Ordinary ponds and fry-ponds (in the foreground of the photo) of Ang Sun Hian near Kampong Fluit (cf. Map I). Embankments planted with coconut palms.

But it is not at all impossible that *Ruppia rostellata* might be able to live and occur in the Batavia empangs in water of still higher salinities than 57.9 $^0/_{00}$.

At any rate the notes in my diary were not collected for the special purpose of ascertaining the highest salinity at which thriving *Ruppia rostellata* may still be met with in the Batavia empangs.

In conclusion it may be recalled here that HORNELL ([31]) mentions another species of *Ruppia*, namely *Ruppia maritima* KOCH, as occurring very generally in the shallow outer sea fish-fonds of Arcachon.

As a third component of the submerged vegetation flourishing in the Batavia empangs must be mentioned *Enteromorpha* (Chlorophyceae, Ulotrichales, Ulvaceae). Portions of a couple of still very young and thin tubes of *Enteromarpha* from the Batavia empangs are represented in fig. 5.

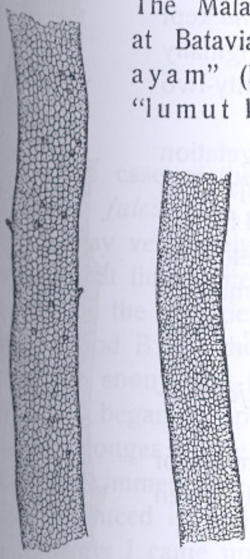

Fig. 5
Portions of two still very young and thin tubes of Enteromorpha from the Batavia empangs. × 30.

The Malay names which I heard applied to *Enteromorpha* at Batavia were "l u m u t p r u t a y a m" or "l u m u t u s u s a y a m" (both signifying "chicken-guts-alga") and sometimes "l u m u t k e m b a n g" (="blossom-alga").

Enteromorpha is very common in the Batavia sea-fish-ponds and often covers several square metres of the surface of a pond. Photo no. 5 (Plate X) shows us the northern end of pond G of Map II, at the surface of which at the moment of taking the photo (27 IV '18, 11 a. m.) nothing but a rather large quantity of *Enteromorpha* was visible [1]).

The young *Enteromorpha*, like the young *Chaetomorpha*, begins to develop from a fixed substratum. I was able to observe this a. o. on March 19th 1918 in pond G of Map II, in which the *Enteromorpha*-vegetation of photo no. 5 (Plate X) was just then beginning to develop from the bottom upward. The older masses of *Enteromorpha* I always found floating freely at the surface of the water, as shown by photo no. 5 (Plate X). This *Enteromorpha*-vegetation of photo no. 5 (Plate X), which therefore had already begun to develop from the pond-bottom about March 19th, 1918 and had arrived at full development about April 27th following, began to droop on May 14th and had disappeared on June 15th. Meanwhile the *Ruppia*-vegetation described above had appeared at the north end of pond G of Map II.

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[1]) Quite beneath the surface of the water there was also to be perceived a young submerged vegetation growing from the pond-bottom upwards, consisting of *Chaetomorpha*, *Ruppia rostellata* and the *Najas falciculata* R. BR. to be further treated below.

Just as for *Chaetomorpha* and *Ruppia* we must bear in mind also in this case, that the data do not permit the inference that (within the limits of the salinities observed: less than $3^1/_2\,^0/_{00}$—84.6 $^0/_{00}$) the salinity has any direct bearing upon the occurrence of *Enteromorpha* in the Batavia empangs.

From the observation-table (Table IV) it appears that on February 6th 1919, in a pond near Kampong Jaagpad, *Enteromorpha* was met with in water possessing a salinity of 3.4 $^0/_{00}$. Similarly there is an entry about a pond near Muara Karang, to the effect that on May 19th, 1919 *Enteromorpha* occurred there in water of 5.45 $^0/_{00}$ salinity. On the other hand the same table shows that in the Batavia empangs "young green *Enteromorpha*" was found at a salinity of 54.6 $^0/_{00}$ (23 XI '18; Jaagpad), and "fresh, already rather thick *Enteromorpha*" at a salinity of 43.6 $^0/_{00}$ (25 XI '18; Muara Karang). Moreover in some experiments with the little fish *Haplochilus panchax* (HAM. BUCH.), to be discussed in Chapter VI, *Enteromorpha* kept well and alive in pond water whose salinity, originally amounting to 60.0 $^0/_{00}$ had risen to 108.0 $^0/_{00}$ in twenty-two times 24 hours by evaporation of the water.

As a fourth component of the submerged vegetation in the Batavia empangs I must mention the Najadacea *Najas falciculata* R. BR. This plant was determined for me by the Botanist for the Java-flora, Mr. C. A. BACKER, who also forwarded a few flowering stems of the material supplied by me to Dr. A. B. RENDLE, London, which specialist confirmed Mr. BACKER's determination.

Figure 6 pictures part of a young leaf of *Najas falciculata* magnified about 40 times.

At Batavia *Najas* is called by the Malay name of "g a n g g a n g", a name which seems, however, to be given also to other higher submerged aquatic plants.

Najas falciculata is very common in the Batavia empangs, but temporarily disappears whenever the salinity exceeds about 30 $^0/_{00}$ [1]). When afterwards the salinity decreases again, *Najas falciculata* is soon observed to reappear in the same places where it used to be found before the increase of the salinity.

When Mr. VAN BREEMEN and myself started collecting with regularity both data and materials at the Batavia empangs, in March 1918, we found *Najas falciculata* in a great many ponds. Thus on March 5th 1918 in the ponds

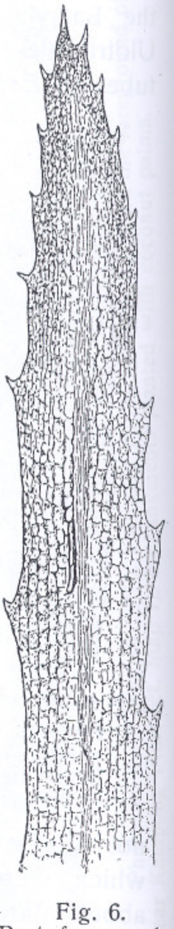

Fig. 6.
Part of a young leaf of Najas falciculata R. BR. from the Batavia empangs. ×40.

1) Some time ago (56) I spoke in this connection of 20 to 25 $^0/_{00}$. I was then thinking more particularly of the highest salinity permitting *Najas falciculata* to keep alive for any length of time. This question can however not be answered without definite culture experiments. I must therefore confine myself here to the question of the highest salinities at which I still found *Najas falciculata* alive in the Batavia empangs.

A and B of Map II a great deal of *Najas* was to be seen growing in water which at the time showed a salinity of less than $3^1/_2$ ‰. On June 27th following the *Najas* had practically disappeared from those ponds, the salinity then amounting to 26.4 ‰ in pond A and 30.4 ‰ in pond B. Between March 5th and June 27th I observed the presence of *Najas falciculata* R. BR. in the ponds A and B at the following salinities:

	Pond A of Map II	Pond B of Map II
5 III '18	< $3^1/_2$ ‰	< $3^1/_2$ ‰
19 III '18	6.2 and 5.7 ‰	6.2 ‰
3 IV '18	12.4 ‰	9.3 ‰
16 IV '18	10.9 ‰	13.1 ‰
27 IV '18	15.1 ‰	13.0 ‰
14 V '18	14.45 and 21.1 ‰	16.7 ‰
28 V '18	15.1 ‰	19.1 ‰
15 VI '18	21.0 ‰	25.2 ‰
27 VI '18	26.4 ‰	30.4 ‰

In this case of the ponds A and B the slow decay and perishing of the *Najas falciculata* vegetation began in reality as early as April 16th, but this may very likely have been owing largely to the fact that the ponds were by that time quite filled up with submerged vegetation and contained little water, the proprietor not being able to conduct more water into the ponds A and B just then.

When soon after the end of June 1918 the high salinities mentioned in Table I began to appear in the ponds A and B, not a trace of *Najas* was any longer to be found in those ponds. On the other hand *Najas falciculata* immediately made its appearance again after the salinities had become reduced in February 1919.

Similarly I came upon a good deal of young *Najas falciculata* on April 3rd 1918, in pond G of Map II, the water in which showed salinities ranging between 7.5 ‰ and 14.3 ‰. As the salinity rose I found live *Najas falciculata* in this pond for the last time on July 16th, 1918; the salinity being 31.7 ‰.

During the period from April 3rd to July 16th, 1918, I found *Najas falciculata* alive in this pond at the following salinities:

3 IV '18	7.5 ‰
16 IV '18	16.7 ‰
27 IV '18	23.6 ‰
14 V '18	21.4 ‰
28 V '18	20.1 ‰
27 VI '18	27.8 ‰
16 VII '18	31.7 ‰

In this pond also the *Najas falciculata* disappeared altogether as the salinity increased, to reappear again when the salinity had fallen in February 1919.

I am however also acquainted with cases of a *Najas falciculata*-vegetation, which had suddenly sprung up, succumbing again in a short time, without any reasonable motive for believing, in connection with my other data, that this could have been brought about by the rather unimportant increase of the salinity during the life of the *Najas*-vegetation.

Thus on March 15th 1918 I found a good deal of *Najas falciculata* in a pond near Heemraad, the salinity of the pond-water being 5.9 ‰. On March 19th and April 3rd following this *Najas*-vegetation was still growing well at salinities of 11.8 ‰ and 10.6 % respectively; but on April 16th it began to languish and die, the salinity being then 13.7 ‰. On May 14th, a salinity of 17.1 ‰ prevailing, there was nothing left of all this *Najas*-vegetation.

In addition to the above my diary furnishes the following data relative to the occurence in the Batavia empangs of *Najas falciculata*, at a definite time, place and salinity:

15 III '18	pond near Heemraad;	S = 3.4 ‰;	Najas falciculata present.
19 III '18	pond near Muara Karang;	S = 6.3 ‰;	Najas falciculata present.
3 IV '18	pond near Muara Karang;	S = 10.8 ‰;	Najas falciculata present.
2 VII '18	pond near Tjilintjing;	S = 21.6 ‰;	old Najas falciculata overgrown with Oscillatoria.
2 VII '18	pond near Tjilintjing;	S = 25.3 ‰;	fine, healthy Najas falciculata.
2 VII '18	pond near Tjilintjing;	S = 31.1 ‰;	old Najas falciculata overgrown with Lyngbya.
22 X '18	pond near Heemraad-Oost;	S = 11.5 ‰;	much Najas falciculata.
22 X '18	pond near Heemraad-Oost;	S = 13.5 ‰;	much Najas falciculata.
22 X '18	pond near Heemraad-Oost;	S = 15.4 ‰;	much Najas falciculata.
24 XII '18	pond near Heemraad-Oost;	S = 20.2 ‰;	very much Najas falciculata.
2 VII '19	pond B of Map II;	S = 13.6 ‰;	Najas falciculata present.
2 VII '19	pond C of Map II;	S = 16.7 ‰;	Najas falciculata present.
2 VII '19	pond G of Map II;	S = 17.1 ‰;	Najas falciculata present.

In the second place the observation table (Table IV) contains the following data concerning the occurence of *Najas falciculata* R. BR. in the Batavia empangs, which data are here found arranged in the order of the salinities:

4.8 ‰	Muara Karang	13 V '19
4.8 ‰	Heemraad-Oost	11 VIII '19

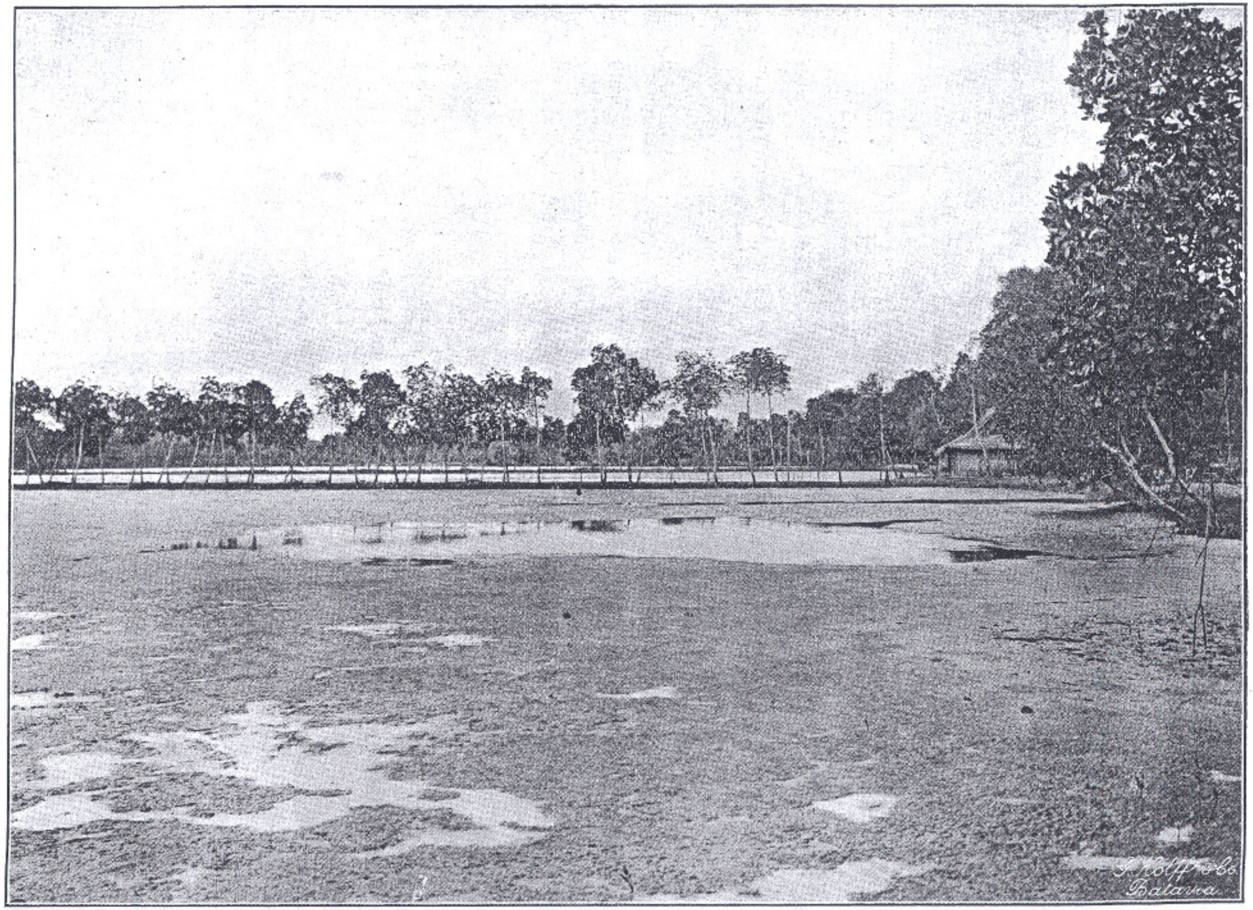

Photo no. 8. (Taken July 2nd, 1918). Ponds near Tjilintjing (cf. Map I). Submerged vegetation consisting of Najas falciculata R. Br., overgrown by Schizophyceae, among which Lyngbya, and of Enteromorpha, Chaetomorpha (herbipolensis Lagerh.?) and Ruppia rostellata Koch. Embankments planted with Rhizophora mucronata Lam. (and Rhizophora conjugata L.).

5.45 ‰	Muara Karang	19	V '19
6.1 ‰	Muara Karang	14	V '19
6.3 ‰	Pekulitan	23	III '19
6.7 ‰	Pekulitan	22	III '19
7.45 ‰	Muara Karang	15	V '19
8.1 ‰	Pekulitan	21	III '19
8.4 ‰	Muara Karang	18	V '19
8.5 ‰	Muara Karang	20	V '19
8.6 ‰	Heemraad-Oost	9	V '19
9.7 ‰	Muara Karang	6	V '19
9.8 ‰	Heemraad-Oost	10	V '19
9.9 ‰	Heemraad-Oost	14	I '19
10.0 ‰	Heemraad-Oost	5	IV '19
10.0 ‰	Heemraad-Oost	13	V '19
10.0 ‰	Heemraad-Oost	21	V '19
10.1 ‰	Heemraad-Oost	7	V '19
10.2 ‰	Heemraad-Oost	8	V '19
10.2 ‰	Heemraad-Oost	11	V '19
10.3 ‰	Heemraad-Oost	16	V '19
10.3 ‰	Heemraad-Oost	18	V '19
10.3 ‰	Heemraad-Oost	19	V '19
10.3 ‰	Heemraad-Oost	11	VIII '19
10.4 ‰	Heemraad-Oost	17	V '19
10.5 ‰	Heemraad-Oost	14	V '19
10.7 ‰	*Heemraad-Oost*	*15*	*V '19*
10.7 ‰	Heemraad-Oost	16	VIII '19
10.8 ‰	Heemraad-Oost	12	V '19
10.8 ‰	Heemraad-Oost	20	V '19
10.8 ‰	Heemraad-Oost	14	VIII '19
11.2 ‰	Heemraad-Oost	6	V '19
12.9 ‰	Muara Karang	7	V '19
14.0 ‰	Heemraad-Oost	16	I '19
14.5 ‰	Luar Batang	18	III '19
15.0 ‰	Heemraad-Oost	31	I '19
15.0 ‰	Muara Karang	26	V '19
15.1 ‰	Heemraad-Oost	18	I '19
15.2 ‰	Heemraad-Oost	15	I '19
15.6 ‰	Luar Batang	19	III '19
15.9 ‰	Muara Karang	27	V '19
16.2 ‰	Heemraad-Oost	17	I '19
17.9 ‰	Heemraad-Oost	20	I '19
18.2 ‰	Heemraad-Oost	21	I '19

18.4 $^0/_{00}$	Muara Karang	23	V	'19
18.7 $^0/_{00}$	Heemraad-Oost	10	I	'19
19.2 $^0/_{00}$	Heemraad-Oost	26	I	'19
19.3 $^0/_{00}$	Muara Karang	25	V	'19
19.9 $^0/_{00}$	Heemraad-Oost	11	I	'19
20.1 $^0/_{00}$	Heemraad-Oost	22	I	'19
20.2 $^0/_{00}$	Heemraad-Oost	24	I	'19
20.3 $^0/_{00}$	Heemraad-Oost	12	I	'19
21.7 $^0/_{00}$	Heemraad-Oost	23	I	'19
21.8 $^0/_{00}$	Heemraad-Oost	27	I	'19
22.75 $^0/_{00}$	Heemraad-Oost	28	I	'19
23.9 $^0/_{00}$	Heemraad-Oost	25	I	'19
26.2 $^0/_{00}$	Heemraad-Oost	4	XI	'18
26.7 $^0/_{00}$	Heemraad-Oost	29	I	'19
27.5 $^0/_{00}$	Heemraad-Oost	19	I	'19
32.6 $^0/_{00}$	Heemraad-Oost	30	I	'19

We are struck in the first place with the fact that *Najas falciculata* was met with very frequently in the ponds of Heemraad-Oost, which ponds are among the exceptional ones in which also towards the end of the East-monsoon the water has a salinity which is generally a good deal lower, or at all events not higher than that of sea-water (cf. Chapter II).

It further appears that out of the sixty cases tabulated above when the presence of *Najas falciculata* was observed, this plant grew:

in 2 cases at a salinity below 5 $^0/_{00}$
in 12 cases at a salinity between 5 $^0/_{00}$ and 9.9 $^0/_{00}$
in 21 cases at a salinity between 10 $^0/_{00}$ and 14.9 $^0/_{00}$
in 14 cases at a salinity between 15 $^0/_{00}$ and 19.9 $^0/_{00}$
in 7 cases at a salinity between 20 $^0/_{00}$ and 24.9 $^0/_{00}$
in 3 cases at a salinity between 25 $^0/_{00}$ and 29.9 $^0/_{00}$
in 1 case at a salinity of 32.6 $^0/_{00}$

To summarize the above I can say that *Najas falciculata* R. BR. was found by me in the Batavia empangs: frequently at salinities below 20 $^0/_{00}$, less frequently at salinities upwards of 20 $^0/_{00}$, only very occasionally at salinities slightly above 30 $^0/_{00}$ and never at a salinity higher than 32.6 $^0/_{00}$.

In conclusion the above shows that *Najas falciculata* R. BR. occurs in ponds situated near Muara Karang, Pekulitan, Luar Batang, Heemraad, Heemraad-Oost and Tjilintjing, that is to say over the entire extent in the direction from West to East of the Batavian fish-pond belt.

PL. XV.

Photo no. 9. (Taken July 2nd, 1918). Ponds near Tjilintjing (cf. Map I). Submerged vegetation consisting of Chaetomorpha (herbipolensis Lagerh.?), Ruppia rostellata Koch, Najas falciculata R. Br., a little Enteromorpha, Oscillatoria and other Schizophyceae. Embankments planted with Rhizophora mucronata Lam. (and Rhizophora conjugata L.).

Besides *Chaetomorpha*, *Ruppia rostellata*, *Enteromorpha* and *Najas falciculata* as the chief components of the submerged vegetation, there is also *Vaucheria* (Chlorophyceae, Siphonales, Vaucheriaceae) which occurs not infrequently in the Batavia empangs. *Vaucheria* is indeed the only alga ("l u m u t") mentioned by VAN KAMPEN (25). This, however, must be due to some accidental circumstance, for the part played by *Vaucheria* in the Batavia empangs is not comparable with that played by *Chaetomorpha*.

I always found *Vaucheria* in the Batavia sea-fish ponds in the shape of black-green sods resting on the bottom, which I could often discern at some distance as black patches visible through the water, and whose diameter was a couple of metres or less. Thus on April 27th 1918 in pond E of Map II I found *Vaucheria*-sods in water of a salinity of 19.2 $^0/_{00}$; on July 16th following the *Vaucheria* patches were still in existence there, the salinity then amounting to 36.5 $^0/_{00}$. On August 12th 1919 I found *Vaucheria* not only in pond E of Map II at a salinity of 35.9 $^0/_{00}$, but also in the ponds B and C of Map II at salinities of 26.7 $^0/_{00}$ and 37.7 $^0/_{00}$ respectively. Also at Tjilintjing, on July 2nd 1918 I found *Vaucheria* in two different ponds.

Vaucheria did not occur in the samples of algae drawn from the Batavia empangs, whose composition is mentioned in the observation-table (Table IV).

Also *Spirogyra* (Acontae-Conjugatae-Zygnemaceae) is of regular occurrence in the Batavia empangs. I came across *Spirogyra* much more frequently than across *Vaucheria* when examining samples of algae drawn from the Batavia empangs; yet I never found large coherent masses of *Spirogyra*, at all comparable with the *Chaetomorpha*-masses or even with the sods of *Vaucheria*. I often found an occasional filament of *Spirogyra* among the *Chaetomorpha* filaments.

As to the occurence of *Spirogyra* at a definite time, place and salinity my diary (1918) and the observation table (Table IV) (1919) yield the following further data:

3	IV	'18;	Pond G of Map II;	14.3 $^0/_{00}$.
16	IV	'18;	Pond G of Map II;	16.7 $^0/_{00}$.
2	VII	'18;	Pond near Tjilintjing;	21.6 $^0/_{00}$.
5	V	'19;	Pond near Muara Karang;	5.5 $^0/_{00}$.
5	V	'19;	Pond near Heemraad-Oost;	10.0 $^0/_{00}$.
7	V	'19;	Pond near Muara Karang;	12.9 $^0/_{00}$.
8	V	'19;	Pond near Muara Karang;	4.7 $^0/_{00}$.
9	V	'19;	Pond near Muara Karang;	4.2 $^0/_{00}$.
10	V	'19;	Pond near Muara Karang;	4.35 $^0/_{00}$.
11	V	'19;	Pond near Muara Karang;	3.95 $^0/_{00}$.
12	V	'19;	Pond near Muara Karang;	4.4 $^0/_{00}$.
15	VIII	'19;	Pond near Heemraad-Oost;	10.5 $^0/_{00}$.

As *Spirogyra* is very slimy to the touch, which is never the case with *Chaetomorpha*, a tuft of *Spirogyra*-filaments is to be distinguished at once from a corresponding tuft of *Chaetomorpha*-filaments.

In conclusion I have to mention that on July 2nd 1918, in a pond near Tjilintjing, I found a Characea which was very abundant there. I have no record of the salinity of that particular pond; in two ponds in close vicinity to the one containing the Characea, the salinity that day however amounted to 26.5 $^0/_{00}$ and 25.3 $^0/_{00}$ respectively.

In the pond in which the salinity was 26.5 $^0/_{00}$ I also found rather important quantities of the little Diatom *Gaillionella* (*Melosira*) (Centricae, Discoideae).

When discussing *Chaetomorpha* I have already had occasion to mention how the general luxuriant development of the submerged vegetation in the Batavia empangs takes place in the Spring after the conclusion of the West-monsoon, or at least after the heavy downpours of rain of a marked West-monsoon have fallen. Accordingly the submerged vegetation may already have reached its maximum development in April.

A luxuriant submerged vegetation having once developed in a couple of weeks' time, the situation often remains stationary for a long time. This became apparent a. o. when twice, on April 16th, 1918, and on the 27th of the same month, I took a photo from the northern extremity of pond A of Map II (cf. Photo 3, Plate VIII), to get a picture of the submerged vegetation existing there; no difference is to be perceived in the extent and distribution of the submerged vegetation as shown in the two photos. In the course of the year, and especially towards the autumn the submerged vegetation usually begins to decline, which is partly connected with the fact that, as we shall see in Chapter V, the submerged vegetation is eaten up by the bigger bandeng, and at that very season there is plenty of large bandeng in the ponds, which is to be caught and sold at "Pasar Malem" [1]).

I furthermore observed how the remains of the old submerged vegetation still existing at the end of 1918, sunk away to the bottom of the ponds when after the dry East-monsoon of that year the heavy West-monsoon rains of the beginning of 1919 set in, which after all, in view of the sudden and great variations in the density of the pond-water resulting from great masses of rain-water pouring into the ponds, is easily accounted for.

In the months July till October 1918 Dr. N. H. SWELLENGREBEL also collected some data concerning the aquatic plants occurring in the sea-fish-ponds of Semarang and Sourabaya. SWELLENGREBEL reports on this subject in the "Communications of the Civil Medical Service in the Netherlands Indies" (Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië), anno 1919, volume VII ([58]) and volume X ([61]).

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[1]) "Pasar Malem" (= Night-Market) is a specifically Batavian festival, celebrated on the two evenings and nights immediately preceding the Chinese New-Year. This latter always falls on or after January 21st and before or on February 20th.

In the first mentioned publication ([58]) SWELLENGREBEL speaks of:

1⁰. floating Enteromorpha;
2⁰. great floating sods of Cladophora;
3⁰. Cyanophyceae in floating cakes mixed with mud;
4⁰. a more or less coherent [1]) film, resting on the bottom of otherwise vegetationless ponds, composed of Cyanophyceae, Diatomeae, Bacteria and microscopic green filamentous algae with a sheath;
5⁰. a fine, green, forked submerged aquatic plant, far more common at Sourabaya than at Semarang;
6⁰. (in disused ponds) large patches of duckweed (Lemnaceae).

In the second publication ([61]) in which, concerning the aquatic flora of the sea-fish-ponds, references to the former publication ([58]) are made nowhere, SWELLENGREBEL mentions:

a. "tubular algae" ("buisalgen");
b. "wad-algae" ("propalgen");
c. "flap-algae" ("flapalgen");
d. "bottom-algae" ("bodemalgen").

From SWELLENGREBEL's descriptions ([61]) it appears with sufficient certainty, that in his second publication ([61]) by „tubular and wad-algae" he means *Enteromorpha*, it remaining however an open question whether his "tubular algae" and "wad-algae" represent different species, or different stages of development of one and the same species of *Enteromorpha*. SWELLENGREBEL's "flap-algae" were quite probably *Chaetomorpha*-masses, as I gather from his descriptions ([61]). If I am correct in surmising this, then in SWELLENGREBEL's description ([61]) (page 141) the word "chromatophores" should be replaced by "pyrenoids" (for this cf. the beginning of this Chapter IV, page 183). That *Chaetomorpha* is common not only in the Batavia empangs, but also in the tambaks in other parts of Java, became manifest to me both when I examined a quantity of algae which Mr. VAN BREEMEN brought along for me from the marine fish-ponds of Sourabaya, and from a short visit I made to the tambaks at Bangil.

Cladophora I never met with in marine fish-ponds in Java. SWELLENGREBEL ([58]) does not state how he came by this name, neither does he give a description of his "*Cladophora*". Further the *Enteromorpha* and "*Cladophora*" of SWELLENGREBEL's first article ([58]) apparently correspond with the "tube- and wad-algae" and the "flap-algae" of his second article ([61]) respectively. In connection with this and with the description given by SWELLENGREBEL ([61]) of his "flap-algae" I think I ought to conclude that by his "*Cladophora*" SWELLENGREBEL must have meant *Chaetomorpha*.

The organisms mentioned by SWELLENGREBEL and quoted by me above sub 3⁰, 4⁰ and d, apparently correspond with my "tay-ayer" organisms.

[1]) As the English equivalent of the Dutch "samenhangend" SWELLENGREBEL uses "continuous".

Lower down in Chapter V the reader will find described, how when the pond is drained dry, the thin upper layer of the bottom held together by the tay-ayer organisms begins to crack and scale off in flakes. Upon the pond being filled again with water, these flakes of the uppermost layer of the pond bottom, held together by tay-ayer organisms, can be seen floating on the surface of the water. The cakes mentioned by SWELLENGREBEL, quoted by me above sub 3°, are most likely of this same origin.

The "fine, green, forked submerged aquatic plant" referred to by SWELLENGREBEL will probably be *Ruppia rostellata* KOCH.

In connection with the extensive masses of duckweed (Lemnaceae) found by SWELLENGREBEL in disused ponds, I must remark that, as Mr. C. A. BACKER, the botanist for the Java-flora communicated to me, so far duckweed has never been met with in brackish or salt water. Therefore the water in the "disused ponds" mentioned by SWELLENGREBEL must have been fresh water. In the Batavia empangs I never found duckweed.

For the connection existing between the submerged vegetation on one hand and the Batavia bandeng-culture together with the production of Anophelines by the Batavia empangs on the other hand, the reader is referred to Chapter V and VII respectively. In conclusion Chapter VIII mentions a few small animals that can constantly be found among the submerged vegetation.

CHAPTER V.

The Bandeng (*Chanos chanos* (FORSK.))

§ 1. Name, affinities and morphological characteristics of the Bandeng.

The fish that is reared in the Batavia empangs is the b a n d e n g [1]), called in WEBER and DE BEAUFORT ([38]) *Chanos chanos* (FORSK.); in VAN KAMPEN ([25]) *Chanos orientalis* C. V.; in GÜNTHER ([5]) and DAY ([7]) *Chanos salmoneus* C. V.; in BLEEKER ([4]) ([1]) beside *Chanos salmoneus* C. V., also a. o. *Chanos indicus* BLKR.. In works on comparative anatomy (cf. GEGENBAUR ([14])) the bandeng is often referred to by the generic name of *Lutodeira*.

In the Cambridge natural History ([29]) the bandeng is referred to by the generic name of *Chanos* in the systematic part and in the general part in the discussion of the accessory branchial organ of certain Clupeidae, the so called "gill-helix"; whilst in the chapter on the alimentary canal of the fishes, in the discussion of the characteristic oesophagus of the bandeng, the name *Lutodeira* only is mentioned. For the numerous other synonyms the systematic literature on this subject should be consulted.

[1]) The name "b a n d e n g" is Malay and Javanese.

PL. XVI.

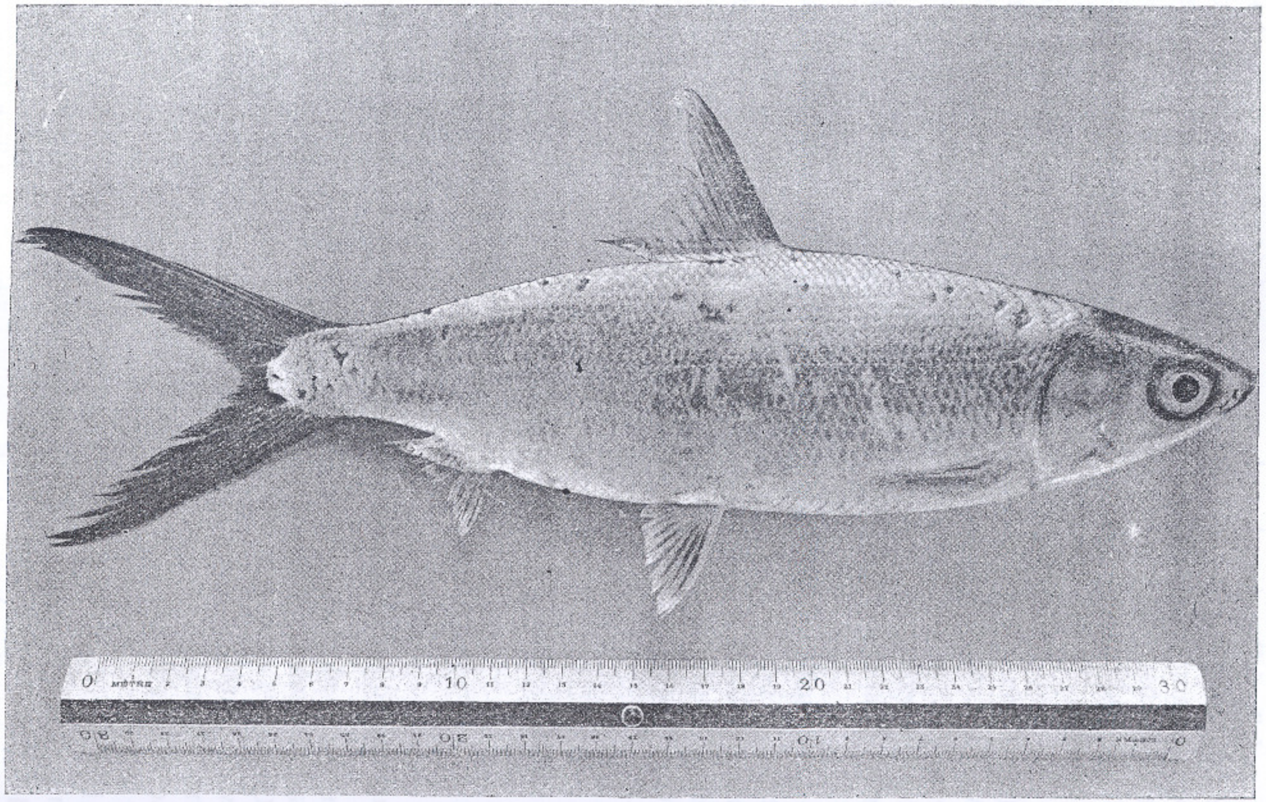

Photo no. 10. Bandeng (*Chanos chanos* (FORSK.)) from the Batavia sea-fish ponds.

The species *Chanos lubina* C. V. still mentioned in BLEEKER (4) and GÜNTHER (5) being no longer recognized (cf. WEBER and DE BEAUFORT (38)), the bandeng is now the only extant living representative known to us of the family of the Chanidae, belonging to the Clupeiformes. The bandeng is however sometimes classed among the family of the Clupeidae, to which is then added the subfamily of the Chaninae (cf. GOODRICH (23)).

Extinct relatives of the bandeng are known to us from the Cretaceous period and that already from the Neocomian epoch, and from the Tertiary period of Europe.

The normal appearance of a bandeng from the Batavia empangs is represented in photo 10 (Plate XVI). Beside this, photo 11 (Plate XVII) pictures a specimen of a markedly deviating shape, which I found on October 17th, 1919 among about 150 fish drawn from the same empang near Kampong Fluit, all the others being normally shaped bandeng. In the subjoined list are collected for comparison some dimensions of : *a.* the biggest specimen of the 150 fish referred to ; *b.* the abnormal individual and *c.* the smallest specimen of the whole batch.

	Biggest specimen	Abnormal individual	Smallest specimen	
length including caudal fin:	59.5	> 32.5	< 43	centi-
maximum height:	13	⩾ 10.5	> 9	metres
diameter of the eye:	2.7	> 2.2	> 2.1	
length of the dorsal lobe of the caudal fin:	16.5	> 14	> 13	
weight:	1820	> 550	< 700	grammes

From these figures it appears that the shape of the body of the abnormal specimen is the result of the growth in the direction of the longitudinal axis of the animal having been far less than normal in proportion to the growth in other directions. One might surmise that this relative shortening of the animal could be wholly or partly explained by the absence of a number of metameres. That this is not the case was clear to me on counting the number of pierced scales constituting the lateral line, respectively the number of transverse rows of scales and the number of vertebrae.

GÜNTHER (5) states 45 as the number of vertebrae of the bandeng. In a normally shaped bandeng from the empangs I counted 44 vertebrae. Of the abnormally shaped individual I could not make out the exact number of vertebrae with certainty, but I could convince myself that it certainly did not deviate much from 44 or 45. The vertebrae, like the animal itself are obviously shortened in the direction of the longitudinal axis. This shortening grows more marked as one approaches the cranial end of the vertebral column, and becomes less pronounced towards the caudal extremity. Moreover the vertebrae are not quite normally shaped and the cranial end of the vertebral column before the attachment to the basioccipital curves slightly dorsad. Further the abnormally shaped specimen corresponds entirely with the properly shaped bandeng as regards the number of transversal rows of scales, respectively the number of pierced scales along the lateral line [1]).

Concerning this number BLEEKER (4) says: "Squamis 75 ad 80 in serie longitudinali basin pinnae caudalis inter et angulum aperturae branchialis superiorem". WEBER and DE BEAUFORT (38) who in their Introduction say (p. XII): "In counting the scales, under "L. l." is given the number of scales with or without sensory organs between the head and the caudal fin or in most cases between that fin and the upper corner of the opercle", state for the bandeng: "L. l. 75—80". Possibly this is derived from BLEEKER (4). In DAY (7) I found "L. l. 80—90"; in GÜNTHER (5) "L. lat. 85—88". GÜNTHER (5) in Vol. I, says concerning the method of counting the scales: "L. lat. gives the number of pierced scales constituting the lateral "line from the humeral arch to the root of the caudal fin, i.e. the number "of transverse series of scales covering the body between the parts mentioned. The scales of the lateral line are often smaller or larger, or irregular, and not congruent with the transverse series; in these cases I have "counted the transverse series".

These figures as given by BLEEKER (4) and WEBER and DE BEAUFORT (38) on one hand, not tallying with those of GÜNTHER (5) and DAY (7) on the other hand, I counted the scales situated "in serie longitudinali" of some ten bandeng. In doing this I counted both the number of scales of the lateral line itself, and above the lateral line the number of transverse series of scales, comprised between the upper corner of the opercular aperture and the basis of the caudal fin. In the same individual I mostly counted about 2 scales less for the lateral line itself than for the number of transverse series of scales on the same side of the body. All the countings however yield results between 83 and 90. It is remarkable that the number of 90 scales happened to come from one side of the body of the abnormally shaped individual, distinguished by its shortening in the longitudinal direction.

In morphological respect the bandeng presents a number of characteristics. The supraoccipital touches the frontals underneath the parietals. From the skull are absent the fossae temporalis and praeepiotica (which are characteristic of the (other) Clupeidae), the fenestra auditoria (which is present in most (other) Clupeidae) and the bullae proötica and pterotica. The accessory branchial organ with the so-called gill-helix (cf. HYRTL (2)) has already been mentioned above. The gill-membranes are entirely united below. Concerning all these points and likewise regarding the peculiarities of the scales, the eyes, the air-bladder, the very few (four) radii branchiostegi etc. the reader is referred to the anatomical and the comparative anatomical literature on the subject.

[1]) Mr. DAVID G. STEAD F. L. S. (Lond.), Fisheries Enquiry Commissioner to the Government of New South Wales who saw the above mentioned abnormally shaped bandeng at my laboratory told me that in Australia be also had met with such abnormally shaped individuals of *Chanos chanos* (FORSK.).

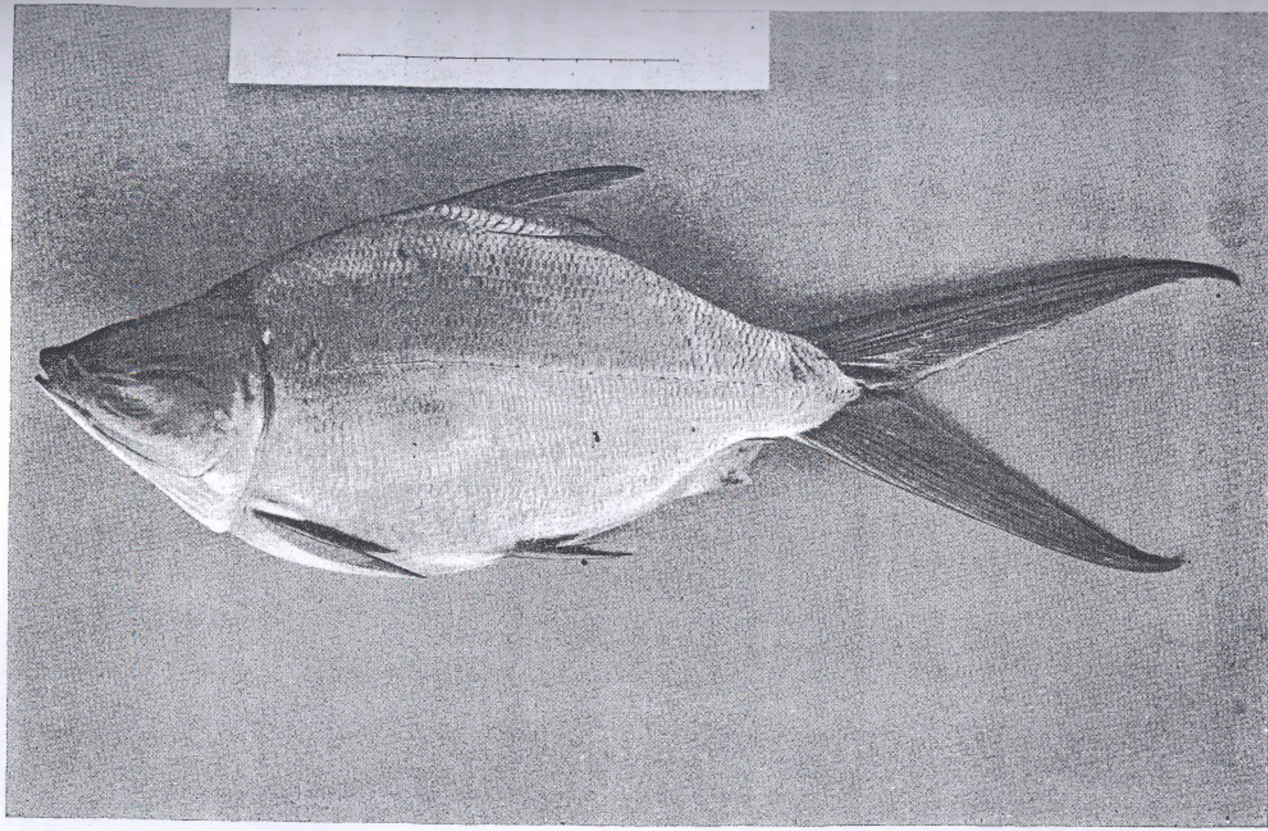

Photo no. 11. Abnormally shaped bandeng (*Chanos chanos* (FORSK.)) from the Batavia sea-fish ponds. Length of the measuring-line near the upper margin of the photo: 10 cM..

Of more importance to us are the morphological peculiarities of the alimentary canal.

It is well-known that the mouth of the bandeng is small and entirely toothless.

WEBER and DE BEAUFORT ([38]) write: "Mouth terminal, small, transverse, bordered above by (the) intermaxillaries, which exclude from the gape the short and broad maxillaries, which have no supplemental bone. The mandibles are overlapped by the upper jaw. They have a symphysial tubercle, fitting into a notch between the maxillaries. No teeth". In concordance with the above words, printed in spaced type, GOODRICH ([23]) also says (p. 392): "maxilla excluded from the gape of the small mouth".

However, as appears from our photo 12 (Plate XVIII), taken from a fresh bandeng, the mouth opening is certainly also bordered by the maxillaries. But in specimens hardened in alcohol it may at first sight make the impression as if the maxillaries were excluded from the gape of the mouth.

It is a very remarkable though a wellknown fact that the oesophagus of the bandeng, before the real U-shaped stomach-bend, forms a complete S-shaped curve. On this subject compare e.g. GEGENBAUR ([14]), II, p. 133; and the Cambridge Natural History, vol. VII ([29]), p. 256; and also our figures 7 (Plate XIX) and 8 (Plate XX). The interior surface of the foremost part of this S-shaped oesophagus-curve, which part passes backwards from the pharynx, displays, as is likewise already known, a number of parallel spiral-folds (cf. fig. 8, Plate XX). Moreover the entire inner surface of this part of the oesophagus is covered with a very large number of papillae [1]), directed backwards, which are largest on the free edges of the spiral folds (cf. fig. 8, Plate XX). The mucous membrane of this fore-part of the oesophagus regularly shows a strong secretion of mucus which envelops the fragments of food.

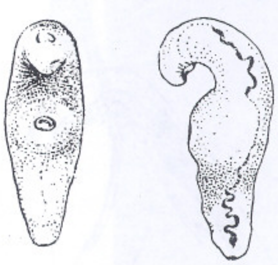

Fig. 9. Trematodes from between the spiral folds of the foremost part of the oesophagus of a bandeng (*Chanos chanos* (FORSK.)) caught in the sea. $\times 7^1/_2$.

In this first part of the oesophagus of bandeng, not from the empangs, but caught in the sea, I often found some of the Trematodes represented in fig. 9.

At A B in fig. 8 (Plate XX) the fore-part of the oesophagus passes into the second part which is directed forward, and this in its turn passes at C D into the third part which again assumes a backward direction. The interior

[1]) I have found no reference to these papillae in the literature at my disposal. GEGENBAUR ([14]), II, p. 133 mentions only "derbe, nach hinten gerichtete Papillen" in the "Anfang des Schlundes" for *Stromateus*. Immediately afterwards he discusses the S-shaped oesophagus-curve of *Lutodeira*, but does not mention the papillae which occur in the foremost part of the oesophagus of het latter animal.

surface of the second and third parts of the oesophagus displays a number of longitudinal folds, these being most strongly developed in the second part. From the beginning of the third part (at C D in fig. 8, Plate XX) down to the beginning of the muscular gizzard (at E F in fig. 8, Plate XX) the longitudinal folds dwindle more and more. The powerfully developed muscular gizzard of the bandeng, which, as has just been said, begins at E F in fig. 8, Plate XX, and which is not mentioned in the literature accessible to me, must obviously be looked upon as the pyloric part of the whole stomach of other Teleosts. This appears in the first place from the fact that this muscular gizzard, as may be seen in fig 7, Plate XIX, runs from left behind to right ahead and secondly from what is stated by GEGENBAUR ([14]), II, p. 133 concerning the muscular gizzard of *Mugil, Heterotis, Meletta thryssa, Phagrus* and the *Mormyrinae*.

Looking upon the muscular gizzard of the bandeng as the pyloric part of the whole stomach of other Teleosts, we are under the necessity of assuming that in the part of the alimentary canal of the bandeng situated between C D and E F in fig. 8, Plate XX, a distinct boundary between oesophagus and cardiac part of the stomach did not yet develop.

It has struck me that in the bandeng reared in the marine fish-ponds of Batavia the muscular layer of that part of the gizzard-wall which is furthest away from the pylorus, may grow much thicker than is the case with bandeng from the sea. In connection with this the gizzard-lumen in sea-bandeng, which is narrowest near the pylorus, grows wider towards the oesophagus, whilst in bandeng reared in the empangs this widening of te gizzard-lumen is again followed bij a more or less pronounced narrowing towards the oesophageal extremity of the gizzard. For this compare fig. 8 (Plate XX) (sea-bandeng) with fig. 10 (empang-bandeng).

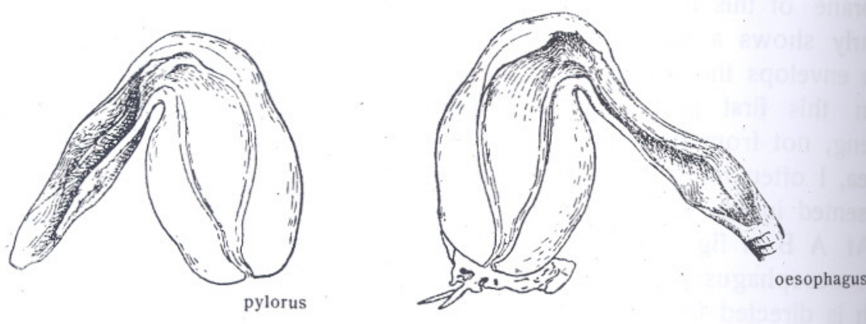

Fig. 10. Longitudinal section through the gizzard of a bandeng (*Chanos chanos* (FORSK.)) from the Batavia empangs. ×1.

Beside these fig. 11 shows a transverse section through the middle of the muscular gizzard of an empang-bandeng. The line A B of fig. 11 is in the

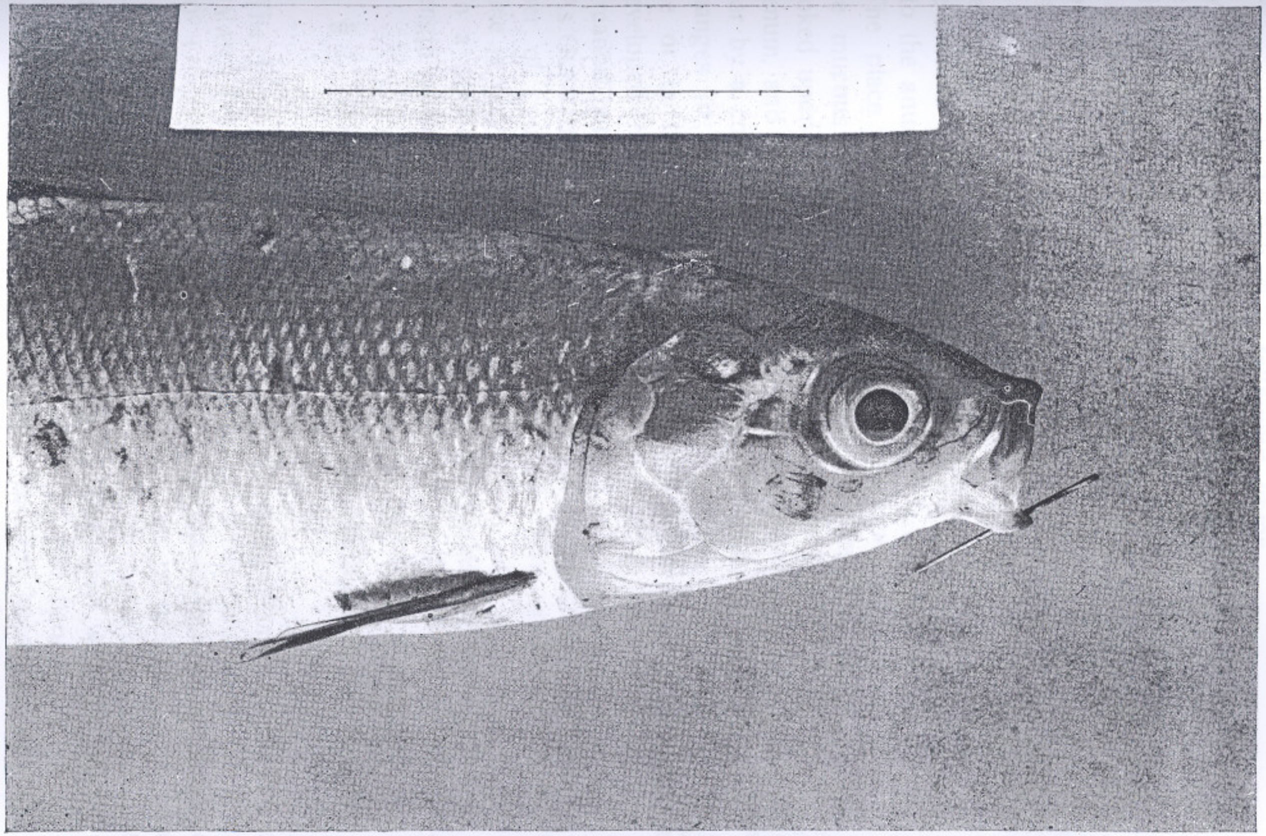

Photo no. 12, showing that the mouth-opening of the bandeng (*Chanos chanos* (FORSK.)) is also bordered by the maxillaries (cf. page 201). Length of the measuring-line near the upper margin of the photo: 10 cM..

plane of drawing of fig. 10, which plane is at right angles to that of fig. 11.

The part of the intestine following immediately after the muscular gizzard is the place where the numerous appendices pyloricae debouch (cf. fig. 8, Plate XX). The next portion of the intestine shows a net-shaped relievo of the mucous membrane, which net-shaped relievo, however, passes very soon (i.e. already at $\pm$ $^1/_{45}$ of the entire length of the intestine from the pylorus up to the anus) into a number of longitudinal folds of the mucous membrane, which continue all the way to the anus (cf. fig. 8, Plate XX).

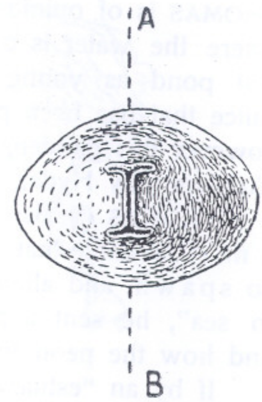

Fig. 11. Transverse section through the middle of the gizzard of a bandeng (*Chanos chanos* (FORSK.)) from the Batavia empangs. × 1.
The line A B is in the plane of drawing of fig. 10 which plane is at right angles to that of fig. 11.

The place where this change in the relievo of the mucous membrane occurs may perhaps be looked upon as the transitional place between duodenum and ileum. Neither by a transverse fold or by a constriction, nor by the appearance of changes in the relievo of the mucous membrance or in the calibre of the intestine there is developed in the bandeng anything like a demarcation between ileum and rectum.

As GÜNTHER ([15]) remarks the intestine of the bandeng displays a large number of convolutions. As a consequence the aggregate length of the intestine is very great.

In a sea-bandeng which, without the caudal fin, measured 87$^1/_2$ cM., the length of the intestine from the pylorus up to the anus was 8 M.

§ 2. Geographical distribution and biological environment of the bandeng.

The bandeng occurs in the entire circumtropical indo-pacific region (ORTMANN ([12])), viz. from the East coast of Africa (including the Red Sea) ($\pm$ 40° Long. E. of Gr.) as far as the Paumotu-islands or Low-Archipelago ($\pm$ 140° Long. W. of Gr.), and from the South of Japan (30 to 40° Lat. N.) as far as New South Wales (30 to 40° Lat. S.) (cf. WEBER and DE BEAUFORT ([38])). Besides it would appear to me that in connection with the nature of its food, of which more will be said below, the bandeng is most likely confined to the litoral region. In the literature accessible to me I have not met with any further indications concerning the proper environment of the bandeng. BLEEKER ([4]) only says: "in mari et in piscinis"; WEBER and DE BEAUFORT ([38]) speak of: "in sea and estuaries"; GÜNTHER ([5]) states: "Indian and Pacific Oceans"; DAY ([7]): "Red Sea, Seas of India, etc.".

DAY (7) however also mentions bandeng as occurring in tanks of fresh and brackish water in South-Canara.

A few further details about this I found in THOMAS (8), p. 218. THOMAS is of opinion that the bandeng occurring in a pond at Cundapur, where the water is only very slightly brackish, must have penetrated into that pond as young fry from the adjoining estuary, through a breached sluice that has been permanently closed afterwards. According to tradition however this bandeng was imported and put into the pond in question at Cundapur by Hyder Ali.

THOMAS (8) also relates how "selecting the month in which he thought it most probable that the Chanos salmoneus would enter the estuaries to spawn, and allowing time for the fry to hatch and grow before going to sea", he sent a peon to the estuary, not the pond, to catch some fry and how the peon found the fry, as predicted.

If by an "estuary" we have to understand a bight of the sea, narrowing towards the interior into a river, or else a wide tidal rivermouth, so in any case a transitional region of some extent between the sea and a river, where sea-water and fresh water mix, in other words where brackish water is found, then, apart from the question as to whether the peon in the case reported by THOMAS (8) caught the fry really in the estuary, I must point out that in our archipelago the fry of the bandeng is certainly also caught in places far removed from anything resembling an estuary. Thus besides near Sedari (in Krawang); near Karang Antu (on the Bay of Bantam); near Tegal; and between Batang and Kendal, there where the railway runs close along the shore, I personally saw on November 4th 1911 at Gayam on the island of Sapudi, bandeng-fry being caught in large quantities. Estuaries, and brackish water in general, were far to seek in the latter case. For completeness' sake I ought however to mention also how Mr. J. Görs, son of the well-known Batavia sea-fish-pond-owner Mr. Max H. Th. Görs, emphatically stated to me more than once that he had seen bandeng-fry of one to two centimetres in length [1]), swimming against the current from the sea into the fishpond-region when he was draining away his fish-pond-water to the sea. Mr. Görs Jr. also told me how after one of his ponds near Pegantungan (cf. Map I) had been entirely cleared of fish, still a couple of years later he found 200 bandeng in it, which in his opinion must have swum spontaneously into the pondregion from the sea as fry.

I already mentioned above how WEBER and DE BEAUFORT (38) state bandeng to occur "in sea and estuaries". This statement induces me to remark that personally I am entirely unaware of the occurrence of bandeng in the mouths of the (not large) rivers in the vicinity of Batavia, which rivermouths however can hardly be called "estuaries". Neither had any of the native fishermen of whom I inquired, ever come across bandeng in

[1]) At Batavia bandeng-fry of this size is sometimes called "daûn assem" (= tamarind leaf).

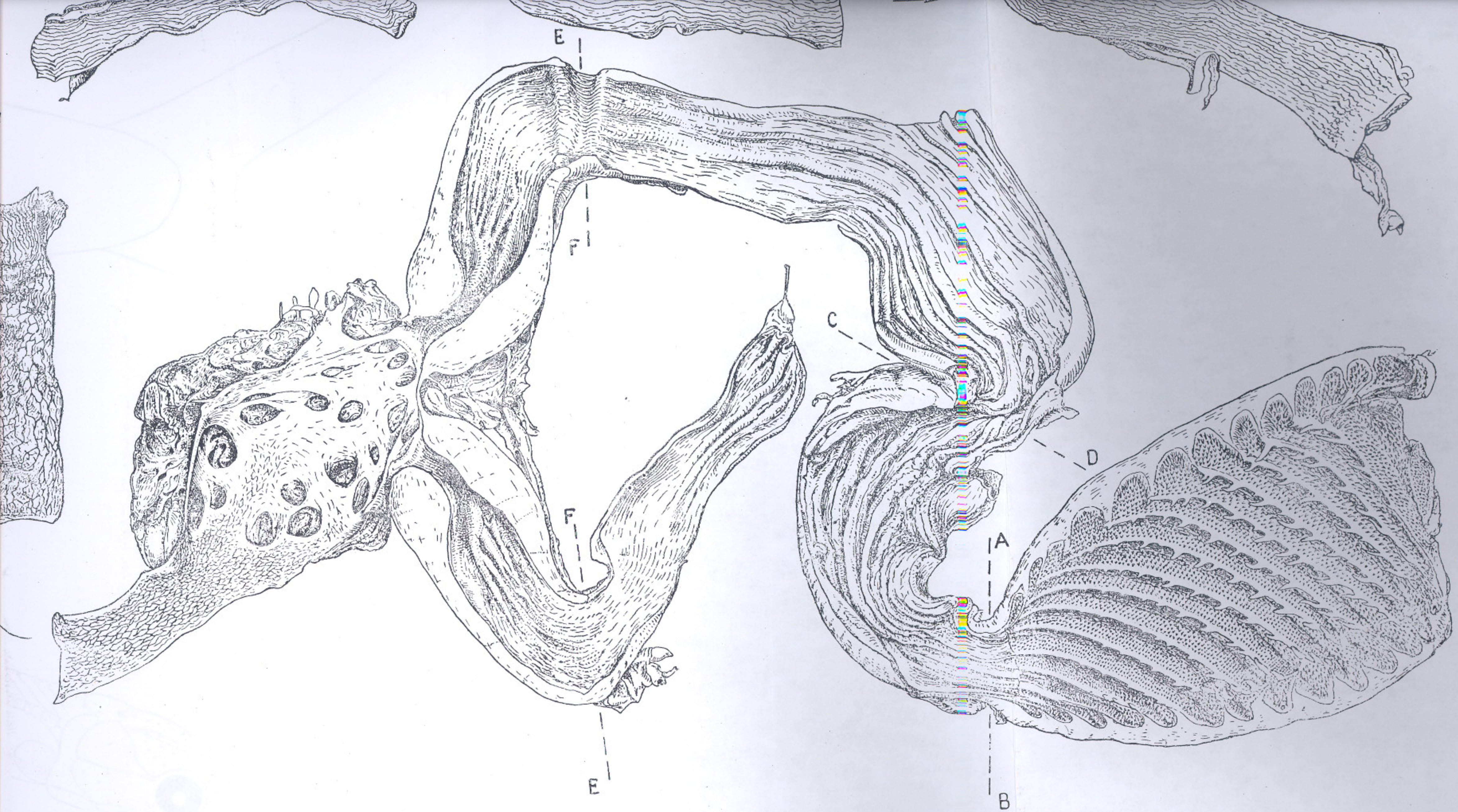

Fig. 8. Tractus intestinalis of the b a n d e n g *(Chanos chanos* (FORSK.)). After a specimen caught in the sea near Batavia. × 1.

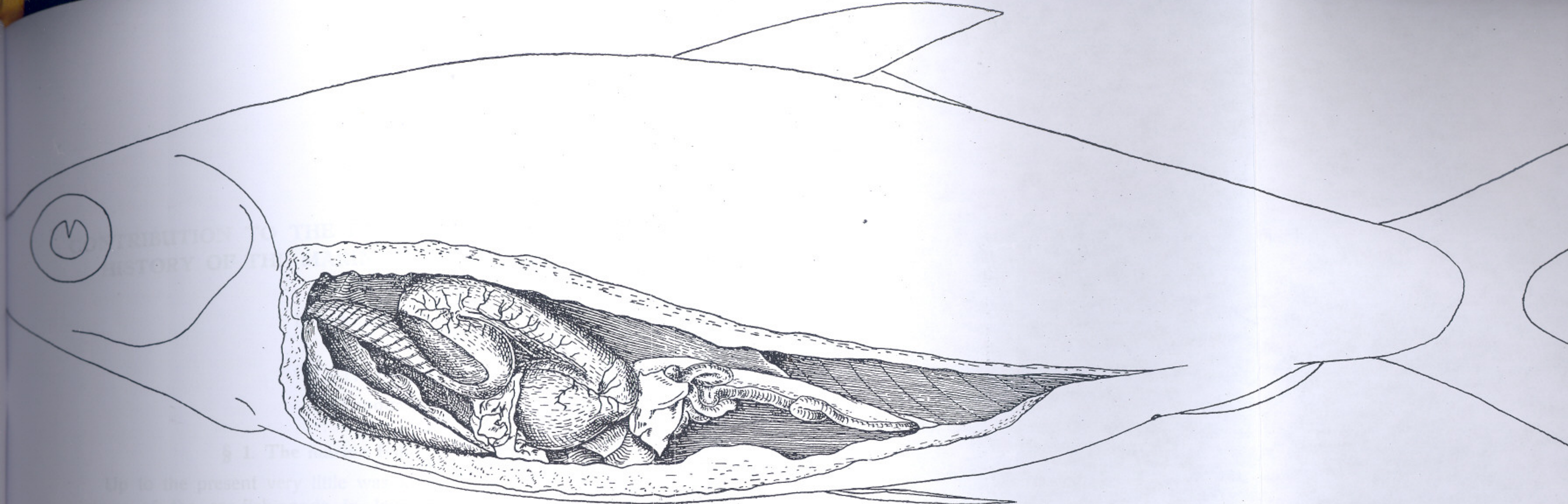

Fig. 7. Situs viscerum of the bandeng (*Chanos chanos* (FORSK.)), after a specimen from the Batavia sea-fish ponds. × 1.

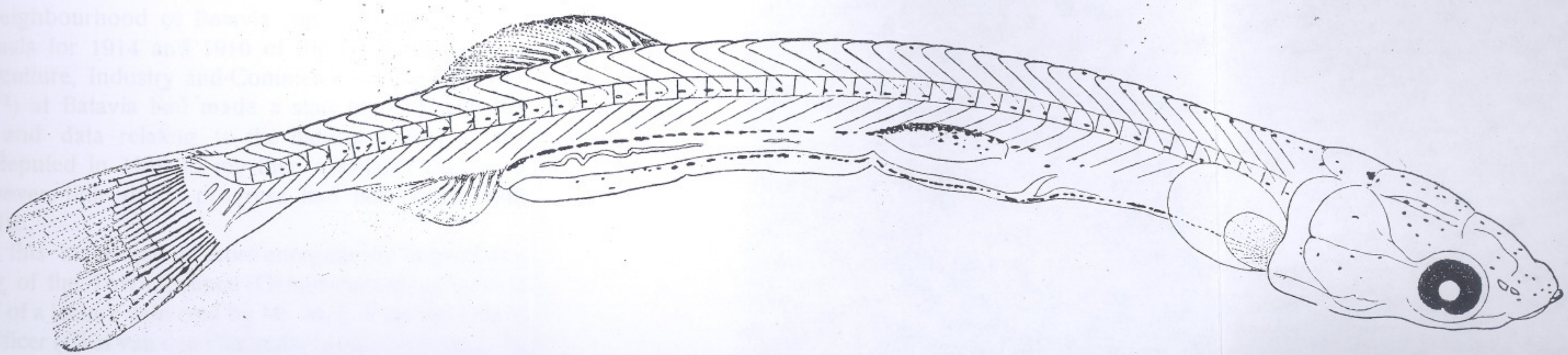

Fig. 12. Fry of the bandeng (*Chanos chanos* (FORSK.)) caught in the sea quite close to the shore. After a specimen sold at the Batavia Pasar Ikan (fish-market). Length $13\frac{1}{2}$ m.m. (× $18\frac{1}{2}$).

CONTRIBUTION TO THE KNOWLEDGE OF THE NATURAL HISTORY OF THE MARINE FISH-PONDS OF BATAVIA

by

Dr. A. L. J. SUNIER.

CHAPTER I.

Introduction.

§ 1. The marine fish-ponds of Java.

Up to the present very little was known about the natural history or biology of the sea-fish-ponds in Java, which are usually referred to by the Javanese name of tambak [1]), and near Batavia by the Malay name of empang [1]), and in which bandeng (*Chanos chanos* (FORSK.)) is reared.

If for the moment we leave out of account the very scant biological data to be met with here and there in the non-biological literature on the Javanese marine fish-ponds — to which literature I shall be obliged to revert later on — then it may be said that practically the only place where a few data corcerning the biology of the empangs are recorded, is the Annual issued by the Department of Agriculture in the Netherlands East Indies, for the year 1907 (25), where Dr. P. N. VAN KAMPEN briefly deals with the marine fish-ponds in the neighbourhood of Batavia (pp. 56—59).

As stated in the Annuals for 1914 and 1916 of the Netherlands East Indian Department of Agriculture, Industry and Commerce (44), the Fisheries Station (Visscherij-Station) [2]) at Batavia had made a start in 1914 with the collection of some facts and data relating to the natural history of the empangs, which work I deputed in 1916 to my then assistant; owing to various circumstances, however, little or no progress had been made with the work until early in 1918.

I was induced to take this investigation more energetically in hand as a consequence of the meeting of the Town Council (Gemeenteraad) of Batavia on February 25th 1918, and of a lecture delivered by Mr. M. L. VAN BREEMEN, at the time Chief Health Officer (Chef van den Gezondheidsdienst) at Batavia, to the Hygienical Circle (Hygienische Kring) at Weltevreden on the 7th March following.

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[1]) The Javanese "tambak" or "tambaq", and the Malay "empang" originally mean a dam or dyke.

(25) This number and all further figures within parentheses, refer to the list of literature consulted.

[2]) Now called "Laboratory for Marine Investigations" ("Laboratorium voor het Onderzoek der Zee").

At the meeting of the Town Council referred to, Mr. VAN AALDEREN discussed an earlier proposal to make no further grants towards the upkeep of the model native village of Taman Sarie, on which occasion certain members had asked for data concerning the state of public health there. Mr. NEEB in this connection remarked a. o. that Taman Sarie was not to be made healthy by local sanitation, as the marine fish-ponds nearly two miles north of Taman Sarie, had been proved to be the breeding-places of a very dangerous malaria-transmitting mosquito which swarmed to Taman Sarie to get its meals of blood there. If those ponds could only be kept clear of all vegetation of algae, then, according to Mr. NEEB, these hatcheries of mosquitoes would very likely disappear.

Mr. VAN BREEN remarked that the views of the Civil Medical Service (Burgerlijke Geneeskundige Dienst) relative to the marine fish-ponds as sources of the malaria-peril, had of late undergone considerable alterations.

In the lecture to the Hygienical Circle, to which reference is made in the above, Mr. VAN BREEMEN discussed the materials concerning the spread of malaria at Weltevreden and Batavia, collected by him in 1917. In connection with the data relative to spleen-index, mortality, breeding places of malaria-transmitters and the occurrence of malaria bearing mosquitoes in the houses, the speaker arrived at the conclusion that the endemic prevalence of malaria at Batavia, can only be accounted for on the assumption that an invasion takes place by the dangerous malaria transmitter *Myzomyia ludlowi* THEOBALD from the enormously productive breeding places, formed by the coastal strip of land, characterized by brackish water and marine fish-ponds, towards the South, where practically no *ludlowi* breeding places occur ([48]).

The discussions following this lecture clearly brought out the fact that we knew virtually nothing as yet about the marine fish-ponds as a biological environment. It was still an open question which factors influenced the production of malaria-transmitting mosquitoes by the marine fish-ponds. Therefore Mr. VAN BREEMEN and myself resolved to collect data as to the sea-fish-ponds as a biological milieu, to do this as regularly as might be once a fortnight for a whole year, and to pay special attention to the factors that influence the production of malaria-bearing mosquitoes in those ponds. I at first cherished a secret hope that the character of the ponds with which I am ex officio so intimately concerned, might prove to be less irretrievably murderous than Mr. VAN BREEMEN contended.

Nobody of course will be inclined to deny that the connection between the biology of the empangs and the endemic prevalence of malaria is a question of economic importance. On one hand any and every endeavour to raise the mass of the native population to a higher economic level, must undoubtedly start from the freeing of that population from the crushing load of various diseases, among which in the foremost place the endemic

Photo no. 1. (Taken in 1915). Little sluice gate connecting two Batavia sea-fish-ponds. Pondsystem of Ang Sun Hian, Groningsche weg near Kampong Fluit (cf. Map I).

malaria; on the other hand the prosperous development of the fish-farming in the marine ponds might in itself form no unimportant contribution to the social income.

In connection with the latter fact it will be easily understood that the Fisheries-Bureau (Afdeeling Visscherij) of the Netherlands East Indian Department of Agriculture, Industry and Commerce is interested in marine fish-farming, as may appear from the 1915/1920 Annals ([44]) of that Department.

Also the Madras Fisheries Bureau as early as 1911 advocated the construction of sea-fish-ponds along the coasts of British India ([31]). It is curious to notice that the author of "Marine Fish-farming for India" ([31]) does not mention the sea-fish-ponds along the Northern coast of Java and is evidently unaware of their existence. The b a n d e n g (*Chanos chanos* (FORSK.)) is not even mentioned by Mr. HORNELL when treating of the species of Indian fish which appear to him suitable to be reared in marine fish-ponds.

HORNELL ([31]) says that at the present day the rearing in ponds of marine fish on anything like an extensive scale, is practically confined to Comacchio in Italy, near Ravenna, and to Arcachon, in France, in the S. E. corner of the Bay of Biscay.

According to HORNELL ([31]) in 1909 the marine fish-ponds of Comacchio covered an area of about 36500 hectares or 90200 acres. Those of Arcachon covered no more than 300 hectares or about 740 acres, which however produced per unit of area (if HORNELL's figures for the two piscicultural centres are quite correct and allow of direct comparison) ten times as much fish as the farming at Comacchio.

As for the marine fish-ponds of Java, those in the Residencies of Sourabaya, Japara, Semarang (Government-land), Pasuruan, Probolinggo, Rembang and Besuki, covered in 1863 according to VAN SPALL ([3]) an aggregate area of 46139 bahus, equal to about 32740 hectares (or 81000 acres).

DE JAAGER and VAN LAWICK VAN PABST ([17]) state that the combined sea-fish-ponds in the residencies of Bantam, Semarang (Government-land), Japara, Rembang, Sourabaya, Pasuruan, Probolinggo and Besuki (in 1885 and 1886 [1])) occupied 50703 bahus [2]), equal to about 35980 hectares (or 89000 acres).

Finally it appears from the data collected in 1903 and 1904 on behalf of the Government Commission on Economic Prosperity ("Welvaart Commissie") ([19]) that the sea-fish-ponds of the Residencies of Bantam, Batavia, Cheribon, Pekalongan, Semarang, Rembang, Sourabaya, Pasuruan, and Besuki, *with the exception of those situated on private estates* (*particuliere landerijen*) aggregated in the years mentioned 66762 bahus which equals about 47380 hectares (or 117000 acres) [3]).

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[1]) Cf. no. 19, a, page 27, of the list of literature consulted.

[2]) In DE JAAGER and VAN LAWICK VAN PABST ([17]) we find on page 140 of the recapitulation $59702^3/_4$. This should be read as $50702^3/_4$. This 9 instead of the 0 is a misprint.

[3]) In addition to these the marine fish-ponds on the island of Madura contained 9978 bahus or 7084 hectares (= $\pm$ 17500 acres).

The restriction "with the exception of those situated on private estates" also applies to the above quoted figures of VAN SPALL (3) and of DE JAAGER and VAN LAWICK VAN PABST (17). This is the reason why the marine fish-ponds near Batavia are not included in any of the above figures. I am therefore unable to state the total area comprised by all the marine fish-ponds in Java. Neither, to my knowledge, are there available any reliable data enabling us to compute the quantity of fish produced by the Java sea-fish-ponds. Hence I am not in a position to draw up a comparison between the marine fish-culture in Java, which is virtually unknown abroad [1]) and the industries of Arcachon and Comacchio described in the literature.

Data concerning the marine fish-farming industry in Java are to be found in VAN SPALL (3), DE JAAGER and VAN LAWICK VAN PABST (17), in the publications of the Commission on Economic Prosperity ("Welvaart Commissie") (19) and in VAN KAMPEN (25).

It is not intended here to go into the details of the industry itself. There are only two points on which I would like to touch.

In the first place there is the question of the origin of the Javanese marine fish-farming in ponds. It is especially the fact that at Batavia, where bandeng-rearing has reached such an advanced stage of development [2]), the owners of the ponds are largely Chinese, which, in connection with the general renown of the Chinese as fishrearers, sometimes leads to the supposition that the empang-industry might be of Chinese origin.

VAN SPALL (3), however, already supplies data suggesting that the tambak-pursuit should be of native origin.

Moreover, VAN DEVENTER (18) on page 113 records how the ancient Javanese laws Kutâra Manâwa, codified about 1400 A. D., threaten with punishments "him who steals fish from a tambak, i. e." (as at the present day) "a salt water fish-pond, an artificial pond along the sea." If therefore the tambak industry should be of Chinese origin, it must have been introduced in Java as early as before 1400. Also the Chinese empang-owners at Batavia believe the Javanese bandeng-rearing to be an originally native pursuit. In this connection it is also significant that DABRY DE THIERSANT (6) in his book entitled "La pisciculture et la pêche en Chine" does briefly discuss the Javanese bandeng-rearing, but does not mention anywhere in his account of the Chinese pisciculture either marine fish-ponds or the bandeng, as connected with China.

In the second place I would draw attention to the construction of the little sluice-gates of the empangs. These will be found described and represented in diagram in VAN SPALL (3) and in DE JAAGER and VAN LAWICK VAN PABST (17). Our photo no. 1 (Plate VI) represents such a small sluice-gate. Now it is remarkable that these little empang sluice-gates

[1]) The marine fish-ponds on Java are briefly discussed by DABRY DE THIERSANT (6) on pages 85 and 86. Cf. p. 219 and 221.

[2]) cf. VAN KAMPEN (25) and TREUB (30).

to be caught and sold at Pasar Malem (30th and 31st of January 1919)[1]), were thronging in the pond closely against this obstacle, trying their utmost to traverse it against the current. The animals pressed against the obstacle with such force and in such dense masses that the upper ones were continually being forced out of the water by those beneath them. Many of them also leapt a height of more than a metre above the surface of the water against the trellis-frame, so that some of them even fell on dry land. I can hardly assume that the slight difference in salinity existing in this case between the up-stream and the down-stream water would be sufficient to account for the excitement of the bandeng.

The bandeng's inclination for swimming against the current is moreover known to the empang-owner, who makes use of it especially to transfer bandeng from one pond to another and also sometimes to catch them.

If in a sluice-gate (cf. photo 1, Plate VI) through which water is made to flow to the pond from which the bandeng must be gathered, the framed trellis-work (k e r e h) is adjusted up-stream, i. e. at the extremity of the sluice-gate away from that pond, the bandeng will crowd together from the pond into the sluice-gate. By subsequently also placing a trellis-fence at the downstream extremity of the sluice-gate the bandeng is locked up in the sluice-gate and can easily be handled. Thus on May 14th 1918 I saw bandeng, collected in this manner in a sluice-gate from a pond down-stream, being transferred across the lattice-fence into a pond situated up-stream by means of a landing-net, so that the fish could be counted at the same time. But for the desire to count the fish, it would have sufficed to remove the up-stream trellis-fence, upon which the bandeng would have swum spontaneously into the up-stream pond.

§ 3. The Food of the Bandeng.

Relative to the food of the bandeng reared in the Batavia empangs I collected the following data which I now draw from the diary I regularly kept during my investigation of the empangs.

On March 5th 1918, Mr. Max H. Th. Görs caused four bandeng to be caught in my presence from one of his ponds, in which, as he expressed it, the fish fed on "mud", and three bandeng from one of his empangs wherein, as he said, the fish ate "l u m u t" (= algae).

Examination showed that the contents of the stomach (gizzard) of the four bandengs which had fed on "mud", consisted of a considerable mass of *Oscillatoria*-threads among which there were also some Rotifera and some mineral particles.

The stomach-contents of two out of the three bandeng, which were said by Mr. Görs to have eaten "lumut", consisted of a large quantity of the leaves of *Najas falciculata* R. BR. and *Ruppia rostellata* KOCH [2]).

[1]) cf. the note at the bottom of page 196.
[2]) Compare Chapter IV.

The stomachs of these animals were closely packed with said leaves. The stomach of the third of these three bandeng was also replete, but contained, besides leaves of *Najas falciculata* and of *Ruppia rostellata*, also some young thin *Enteromorpha*-tubes and a few *Folliculina*'s [1]), belonging to the Ciliata Heterotrichida, and living attached to algal filaments.

While the fish were being caught Mr. Görs informed me that when feeding on "mud" the bandeng does not grow well. The proper food of the larger bandeng was "lumut", that is to say the submerged vegetation consisting chiefly of *Chaetomorpha*, further of *Enteromorpha* and *Ruppia*, sometimes of *Najas* and often of still other components, which reaches up to just beneath the surface of the water, and which has been described in Chapter IV (compare also our photos 2, 3, 4, 6, 8, 9, 14 and 15; Plates VII, VIII, IX, XI, XIV, XV, XXII, and XXIII).

On the other hand "mud-cream" or "tay-ayer" was the right food for the bandeng-fry.

In Chapter IV I have already stated that "tay-ayer" consists mainly of Schizophyceae-threads (*Oscillatoria, Lyngbya, Spirulina, Microcoleus, Nostoc*, etc.) and further also of Diatoms such as *Pleurosigma*. I also stated there that "tay-ayer" develops at the bottom of the empangs especially after that bottom had been lying dry for a couple of days. Since the stomachs of the bigger bandeng which according to Mr. Görs had fed on "mud" contained a large quantity of *Oscillatoria*-filaments, it seems to me that there is not so very much difference between what Mr. Görs calls feeding on "mud" and feeding on "mud-cream". In both cases the food consists of the "tay-ayer" organisms, developing at the bottom of the ponds, as described in Chapter IV. The only difference is that the larger ponds of Mr. Görs, among which are also those in which "lumut" is not available, so that the bandeng must needs feed on "mud", are not so often drained dry as the smaller fry-ponds in which the bandeng-fry eats "mud-cream", the regular laying dry of the fry-ponds taking place, also according to Mr. Görs, for the very purpose of promoting the growth of "tay-ayer". I conclude therefore that in this case I ought to understand "mud" as meaning a less rich development of "tay-ayer", and "mud-cream" as designating a richer development of the same.

This laying dry of the fry-ponds in particular is indeed already mentioned by VAN SPALL ([3]) (page 29) and by DE JAAGER and VAN LAWICK VAN PABST ([17]) (page 21). The latter authors ([17]) however also discuss (page 23) the laying dry of the larger ponds and its importance for the feeding of the bandeng [2]). VAN KAMPEN ([1]) also says: "The laying dry" (of a pond in general) "appears to be necessary in order to prevent the souring of the soil, and to promote the growth of the algae that serve as food for the fish".

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[1]) Compare Chapter VIII.
[2]) Compare also our page 219.

That same day, March 5th, 1918, I moreover saw how young bandeng of about five centimetres long were fed with *Enteromorpha* chopped small.

On March 19th, 1918, I had another opportunity of examining the contents of the stomachs of four bandeng, caught especially for the purpose, which had fed on "mud". These stomach-contents all consisted of *Oscillatoria*-filaments among which there were occasional Chroöcaccaceae (*Gloeocapsa*, *Microcystis* (?)).

That same day I also saw in one of Mr. Görs's ponds a good many fragments of *Ruppia rostellata* plants floating about, of which the leaves had evidently been eaten away by the bandeng. Such a fragment is represented in fig. 13, whereas fig. 4, Plate XII, shows a part of an intact *Ruppia rostellata* plant from a Batavia empang. In the stomach of a bandeng, caught from the pond in which those leafless fragments of *Ruppia rostellata* plants were floating about, I actually found *Ruppia* leaves, of which moreover, as stated above, I had already found large quantities in a bandeng-stomach on three former occasions.

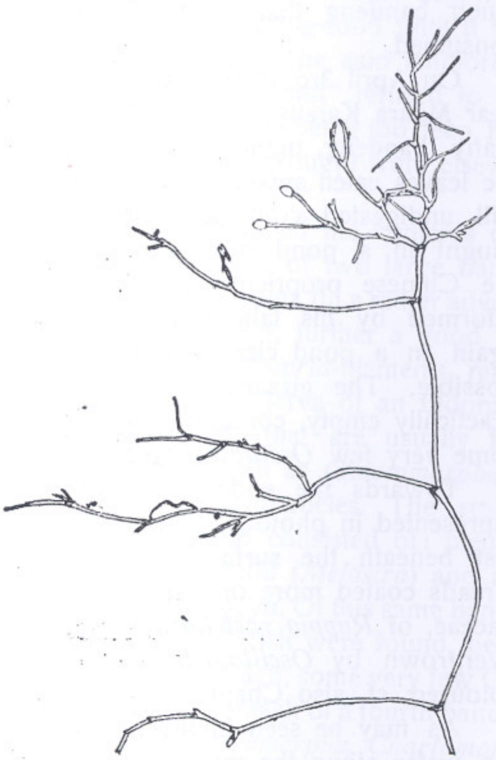

Fig. 13. Fragment of a *Ruppia rostellata* KOCH plant of which the leaves have been eaten away by the bandeng, drawn from a Batavia empang in which many of such fragments were found floating about. × 1.

Mr. J. Görs Jr. further informed me on this occasion, how in a pond from which the bandeng had been caught away, he first gave the submerged vegetation consisting chiefly of "lumut kain" (*Chaetomorpha* (*herbipolensis* LAGERH. (?)) and further of the other plants described in Chapter IV, a chance to develop again as food for the bandeng, before he let loose new bandeng into such a pond. Thus pond G of Map II at that moment contained no bandeng.

Regarding the submerged vegetation which began to develop at that moment in this pond G, compare Chapter IV.

That same 19th March Mr. J. Görs Jr. also showed me the pond F of Map II, near the sea. That pond at the moment contained no "lumut" [1])

[1]) By "lumut" (= algae) or "algal" vegetation is meant here and in this Chapter in general the submerged vegetation described in Chapter IV, consisting mainly of *Chaetomorpha* and reaching up to just beneath the surface of the water.

at all, but it held a large number, viz. as many as 4000 rather young bandeng, which as Mr. Görs said were feeding on "mud". Under these circumstances however, the animals could not thrive, and they were therefore shortly to be transferred to one of the more inland ponds in which the "lumut" had been allowed to develop quietly. The entire absence of "lumut" at that moment from pond F of Map II, according to Mr. Görs Jr. was chiefly owing to the fact that this pond contained so much bandeng that all the "lumut" developing there was immediately consumed.

On April 3rd 1918, I saw once more not only in a pond of Mr. Görs's near Muara Karang, but also in a pond near Heemraad, containing a great many bandeng, numerous pieces of *Ruppia rostellata* floating about with the leaves eaten away. On that same day I could further examine again the still undigested contents of the stomachs of two bandeng which I saw caught in a pond near Muara Karang, which pond had been leased by the Chinese proprietor to another Chinese fish-farmer. The latter, I was informed by his labourers, did not leave the "lumut" time to develop again in a pond cleared of fish, but turned in new bandeng as soon as possible. The gizzards of these bandeng were strongly contracted and practically empty, containing only a few Rotatoria, a minute water-bug and some very few *Oscillatoria*-filaments.

Towards the end of June I came upon the submerged vegetation represented in photo 4, Plate IX, in pond G of Map II. It reached up to just beneath the surface of the water and consisted of *Chaetomorpha*-threads coated more or less with Chamaesiphonaceäe and Chlamidobacteriaceae, of *Ruppia rostellata* KOCH, and of *Najas falciculata* R. BR., all this overgrown by *Oscillatoria* and other Hormogoneae, by *Gloeocapsa* (red-coloured, cf. also Chapter IV), etc..

As may be seen in the right-hand lower corner of photo 4, Plate IX, the water along the margin of the pond was open; the submerged vegetation occupying the shallower (cf. page 165) central part of the pond. The rounded bights of open water along the margin of the submerged vegetation are due to the bandeng having eaten away parts of that vegetation in those places.

This I could observe on June 27th and 29th, 1918, when I saw how in the round bights just mentioned several of the many bandeng swimming about in the marginal ditch (cf. page 165) came ever and anon to eat of the submerged vegetation. The animals with their mouths close beneath the surface of the water then took a mouthful of the edge of the submerged vegetation, sometimes loosening it with a few jerks. In this same pond I afterwards saw on three more occasions, viz. on July 16th, July 30th and September 6th a number of bandeng eating together of the submerged vegetation.

On June 29th 1918, in a pond belonging to Ang Sun Hian near

Kampong Fluit (cf. Map I) I saw cut grass being thrown into the pond as food for the bandeng.

On July 2nd 1918, at Tjilintjing, I saw bandeng-fry being fed with dedek (=rice-bran). VAN SPALL (3) also states that the bandeng-fry is occasionally fed with bran (cf. also page 219).

The Chinese landlord of Tjilintjing, the owner of the ponds reproduced on photos 8 and 9 (Plates XIV and XV) told me that same day that the *Chaetomorpha* vegetation is not at its best as bandeng-food until it begins to grow old and turn yellow (cf. Chapter IV). The said landlord also informed me that having a pond in which the "lumut" refused to grow, which in his opinion was owing to the pond in question being too deep, he had caused prahu-loads of lumut kain (*Chaetomorpha*), brought from elsewhere, to be cast into the pond.

Finally on Juli 2nd 1918 at Tjilintjing I examined the contents of the stomachs of four more bandeng. In the stomachs of two large bandeng caught in one and the same pond, I found the remains (in a rather advanced stage of digestion) of leaves of *Najas* and *Ruppia*, further a good many *Vaucheria*-filaments, *Chaetomorpha*-filaments, *Oscillatoria*-filaments, remains of the tissues of higher plants (detritus), a small larva of an Odonate, a number of the small (shell-bearing) Gastropods that are usually found among the filamentous algae in the empangs, such as *Chaetomorpha* and *Vaucheria* (cf. Chapter VIII) and some mineral particles. The stomach contents of a third bandeng, from an other pond consisted of: plenty of *Chaetomorpha* and *Enteromorpha*, much *Gaillionella* (*Melosira*) and a few other Diatoms, some *Najas*-leaves and some *Lyngbya*. Of this same bandeng I also examined the contents of the intestine, in which were found, besides the food components already met with in the stomach, some very few Copepods and some very few *Folliculina*'s. In the stomach of a fourth bandeng, weighing $\pm$ 8 catties (= $\pm$ 5 K.G.), I found: *Enteromorpha, Chaetomorpha, Ruppia*-leaves and *Gaillionella*.

On July 3rd 1918 I examined the contents of the stomach of a bandeng brought to the Batavia Pasar Ikan (fish-market) from the empangs. It consisted of: a few *Pleurosigma's*, and a few other bottom-Diatoms, a few bits of higher-plant tissues (detritus), a few Copepods, an occasional Ostracod, a few detached parts of the exoskeleton of small Entomostraca, and some mineral particles.

Also of a few very young and small bandeng I was able to examine the contents of the stomach, respectively of the intestine.

Thus on May 17th 1918 I bought some 30 bandeng-fry, which were turned into a small aquarium containing empang-water into which some *Chaetomorpha* had been put. On putting into this aquarium a quantity of "tay-ayer" from the empangs consisting of Schizophyceae-filaments (*Oscillatoria, Lyngbya, Nostoc* etc.) I found the young bandeng falling to very eagerly. The young animals however also ate of the filmy layer of

Diatoms which developed richly on the glass wall of the aquarium. To do this they swam to and fro close to the glass wall, more or less sideward, that is to say in such a way that the longitudinal axis of the body usually formed an angle of more than 45° to nearly 90° with the wall. Every now and then they darted forward till their mouth touched the wall and they could take a mouthful. Accordingly when on July 30th 1918, after the aquarium had not contained any more "tay-ayer" for a few days past, I examined the contents of the intestine of a few of these bandeng, then measuring 3.2 cM., inclusive of the caudal fin, this proved to consist entirely of a very large quantity of *Pleurosigma*-like Diatoms.

That same day I likewise examined the stomach-contents of a young bandeng caught in one of the fry-ponds C of Map II, which, again including the caudal fin, measured $8^1/_2$ cM. The contents of its stomach consisted of: very small fragments of Schizophyceae-threads, a few small Diatoms and some fine mineral particles.

On September 6th 1918 I once more [1]) saw, this time in the empangs of Ang Sun Hian near Kampong Fluit, how young bandeng were fed with *Enteromorpha* chopped small. They were little fish of about 6 centimetres. I was informed that this feeding took place once a week.

On September 24th 1918 I had again the opportunity to examine the stomach-contents of four young bandeng, about 10 centimetres long, taken from one of the fry-ponds C of Map II. The stomachs of these animals were strongly contracted and practically empty; the only things I found in them being a few *Oscillatoria*-threads, a few filaments of Nostocaceae, some small Diatoms, a few somewhat larger *Pleurosigma*-like Diatoms and some mineral particles.

On December 6th 1918 I again examined the intestine-contents of a bandeng brought from the empangs to the Batavia Pasar Ikan (fishmarket); it proved to consist of a fair quantity of *Pleurosigma*-like Diatoms, some *Chaetomorpha*-filaments, some remains of tissues of higher plants (detritus), some Copepods, a few Ostracods, a few small Dipterous larvae, a few fragments of the exoskeleton of small Crustacea, some very few *Folliculina*'s and some mineral particles. The foremost part of the oesophagus (with the spiral-folds) of this same bandeng contained: a few *Pleurosigma*-like Diatoms, a few *Chaetomorpha*-threads, a few remains of higher-plant tissues (detritus) a few Ostracods, the chitin-skeleton of the head of an eucephalic Dipterous larva and some mineral particles.

On January 28th 1919, on the occasion of the catching of the bandeng for the Pasar Malem [2]) I was offered another chance of examining the contents of the tractus intestinalis of eleven large bandeng. All these eleven bandeng originated from the same pond, situated just West of the pond system of Map II. The gizzards of the first five bandeng were closely

[1]) cf. page 209.
[2]) cf. note page 196.

stuffed with *Vaucheria-* and *Chaetomorpha*-threads. Of the remaining six bandeng I examined not only the contents of the gizzard, but also those of the oesophagus and the intestine. It then appeared that of these six bandeng the entire intestinal tract from the mouth to the anus was filled with *Vaucheria-* and *Chaetomorpha*-filaments.

If on the one hand, as described above, I several times saw, in June, July and September 1918, the bandeng eating quite near the surface of the water of the submerged "algal" [1]) vegetation consisting chiefly of *Chaetomorpha* and reaching up to just beneath the surface of the water, on the other hand I observed on August 12th 1919 a crowd of bandeng feasting on the masses of *Vaucheria* occurring on the bottom of pond B of Map II. The animals were standing head-down in the water so that the longitudinal axis of their bodies was at an angle of between 45° and 60° with the level of the water, whilst the dorsal lobe of the continually moving caudal fin emerged like a little flag from the shallow water of the centre of the pond where the animals were „grazing".

In connection with these data relative to the food partaken of by the bandeng living in empangs the following also seems to me not devoid of interest. On November 30th 1918 I saw masses of *Chaetomorpha* gathered elsewhere, being brought in picul-loads by some coolies to Pekulitan, where the bandeng was to be fed with these algae. I also saw in the pond-system of Map II how for instance when a pond had become too full of *Chaetomorpha,* part of the algal masses were hauled out of the pond and then stacked in a sort of rick, so as to serve afterwards as bandeng-food in cases of temporary or local scarcity of algal vegetation.

I also endeavoured to collect data concerning the food of bandeng living in the sea, i. e. in their natural environment. However, as I had occasion to state before, sea-bandeng is but rarely marketed at the Batavia Pasar Ikan (fish-market).

As is well known and has also been remarked by THOMAS ([8]) bandeng is not to be caught with hook-tackle. The occasional sea-bandeng marketed at Batavia is caught with the payang-teri [2]) (a seine), or in the sero's [2]) (fishing-stakes), sometimes also with the tempuling [2]) (a harpoon). Consequently the number of sea-bandeng whose stomach- or intestinal contents I was able to examine was not very large, as may appear from the following survey.

1. December 10th 1918; Intestinal contents of a sea-bandeng: a fine brown-green ooze, which under the microscope proved to consist of: a great many *Pleurosigma*-like Naviculinae, a good many Globigerinae, a few Rotalidae, some very few *Polystomella's,* an occasional Copepod, some mineral particles.

2. December 11th 1918; Stomach-contents of a sea-bandeng: a good many *Pleurosigma*-like Naviculinae, some Rotalidae, Miliolidae, Textularidae

[1]) cf. note page 209.
[2]) On native fishing-gear compare VAN KAMPEN ([27]).

and Globigerinae, an occasional *Codonella*, a few *Thalassiothrix nitzschioides*, a few *Chaetoceras*-horns, a very small *Coscinodiscus*, a small Ostracod, one half of a very small Lamellibranchiate-shell, rather many mineral particles;

oesophagus-contents of the same sea-bandeng; rather many *Pleurosigma*-like Naviculinae, a rather great quantity of *Thalassiothrix nitzschioides*, a few representatives of fine *Chaetoceras*-species among which *Chaetoceras secundum*, a number of long serrated horns of representatives of bigger *Chaetoceras*-species, a few *Bacteriastrum's*, a few *Rhizosolenia's*, a rather thick Schizophyceae-filament, a few remainders of vegetable tissue (of higher Algae?), some Rotalidae, an occasional Miliolid, an occasional Textularid, an occasional *Codonella*, a very small shell-bearing Gastropod, a fair number of minute Lamellibranchiates, an occasional small Copepod, a Copepod-larva, some mineral particles.

3. September 3rd 1919; sea-bandeng 93 cM. long exclusive of the caudal fin; intestinal tract empty, no recognizable remains of food to be found; stomach empty, no recognizable remains of food to be found.

4. September 11th 1919; sea-bandeng, a little over 80 cM. long, not including the caudal fin; contents of the fore part of the oesophagus: a small quantity of fragments of vegetable tissue, presumably of higher Algae (Phaeophyceae, Ulvaceae?).

5. October 14th 1919; contents of the stomach of a sea-bandeng: a fine brown ooze, which under the microscope proves to consist of: a very large number of *Pleurosigma*-like Naviculinae, a few Rotalidae, some vegetable detritus (of higher Algae?), some mineral particles;

intestinal contents of the same sea-bandeng: a fine brown ooze, which under the microscope proves to consist of: a large number of shells of *Pleurosigma*-like and also *Navicula*-like Naviculinae, a fair number of Rotalidae, a few fragments of parenchymatous vegetable tissue (higher Algae?) an occasional small Copepod, some mineral particles.

6. October 17th 1919; intestinal contents of a large sea-bandeng: some benthos [1])-Diatoms, a few Foramimifera, some *Chaetoceras*-horns, a minute *Coscinodiscus*.

7. October 21st 1919; stomach contents of sea-bandeng; large quantities of benthos-Diatoms (Naviculinae) a few empty *Rhizosolenia*-shells, a number of Gammaridea in black dwelling-tubes, some mineral particles.

8. November 10th 1919; sea-bandeng 76 cM. long, not including the caudal fin; contents of oesophagus: a quantity of small karyo-enteric Salpae.

9. November 14th 1919; sea-bandeng; contents of intestine (just beyond the stomach): remainders of vegetable tissue in an advanced stage of digestion (higher Algae?).

How can the above data be summarized?

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[1]) benthos-Diatoms = Diatoms living on a firm substratum, in contradistinction to plankton-Diatoms.

In the first place then it has become clear that the bandeng living in the sea, i. e. in its natural environment partakes (among other things) of large quantities of benthos-Diatoms. For I frequently found in the intestinal tract of bandeng caught in the sea, large quantities of *Pleurosigma*-like and also *Navicula*-like Naviculinae, that is to say Diatoms living at the sea-bottom or on another firm substratum (benthos), mixed with mineral particles. Many of the other organisms also found in the intestinal tract of sea-bandeng in these cases, such as *Chaetoceras, Bacteriastrum, Rhizosolenia, Thalassiothrix nitzschioides, Coscinodiscus, Globigerina, Codonella* etc. belong indeed to the plankton, but it is well-known that (as is indeed self evident) they or at least their dead bodies regularly get to the bottom of the (shallow) sea.

Secondly, in the alimentary canal of four sea-bandeng I found remains of multicellular plants, probably of higher Algae, such as Phaeophyceae.

I think I may infer from the above that the sea-bandeng so to say takes the cream off the upper layer of the sea-bottom, which contains a good many living or dead microscopic organisms, in doing which they absorb chiefly great quantities of microscopic vegetable organisms and (at the same time together with these) also some Foraminifera, some minute Lamellibranchiates, some small Gastropods, and likewise some (dead bodies of) Copepods. If in doing so the bandeng comes across multicellular vegetable organisms living on the sea-bottom, they feed also on those.

How far the above constitutes a picture of the normal way sea-bandeng feeds, I cannot say. For the small number of nine bandeng of which I was able to examine the food-remains in their intestinal tract, had all been caught with the payang-teri [1]) or in the sero's [1]) close to the coast of Batavia, in very shallow water, on a mud-bottom. It is not impossible that the alimentary canal of sea-bandeng caught in an other biological environment might contain quite a different kind of food-remains. As to the black dwelling-tubes containing Gammaridea, these I found comprised in a white mass which to me was irrecognizable, so that I do not venture to guess how and with what other food these Gammaridea were swallowed. Neither can I say much about the small karyo-enteric Salpae found once in the oesophagus of a sea-bandeng. From the nature of the case there is a possibility of these pelagic animals, feeding exclusively on minute phyto-plankton organisms, having been absorbed by the bandeng at the bottom of the sea, where they had got to under certain circumstances (perhaps dying or dead).

As regards the food of the pond-reared bandeng, the data collected and discussed above mainly show:

1o. that the young empang-bandeng feeds on the Schizophyceae and Diatoms developing on the pond-bottom.

2o. that at Batavia the older empang-bandeng frequently also feeds on Schizophyceae and Diatoms just mentioned as developing on the pond-bottom, but that the food of the bigger bandeng there consists in the first place of the

[1]) cf. VAN KAMPEN (27).

submerged vegetation, described in Chapter IV, which, growing from the pond-bottom upward soon reaches up to just beneath the surface of the water, or, becoming detached from the pond-bottom floats up against the water-surface; this vegetation consisting mainly of *Chaetomorpha*, coated or not with Chamaesiphonaceae, Chlamydobacteriaceae etc., but further also of *Ruppia rostellata*, *Enteromorpha* and sometimes *Najas falciculata*, and being frequently overgrown with all kinds of Schizophyceae (*Oscillatoria*, *Gloeocapsa* etc.).

From what was already stated before it further appears that *Vaucheria* as a food of empang-bandeng in a certain respect holds a peculiar place. For whereas *Vaucheria* and *Chaetomorpha* are both filamentous algae, which regarded as bandeng-food have certainly a good deal in common, and which accordingly were often found together by me in the alimentary canal of empang-bandeng, *Vaucheria*, growing on the pond-bottom, never, as far as I could observe, comes floating up against the surface of the water, as *Chaetomorpha* is so apt to do. I will revert to this again in Chapter VII.

Still more clearly than from the data I could gather concerning the food of the sea-bandeng it appears from the food-remains found in the intestinal tract of many empang-bandeng, that this fish is a vegetarian. As a matter of fact it is easy to understand that in the same way as mineral particles are absorbed from the pond-bottom by the bandeng swallowing Schizophyceae and Diatoms, so small animal organisms such as Ciliates, Rotifera, small Gastropods, small Insects (waterbugs, little Odonate-larvae, Dipterous-larvae) and small Crustaceans (Copepoda and Ostracoda) living either on the pond-bottom or between the *Chaetomorpha*-vegetation, are likewise swallowed down together with the vegetable food. I already mentioned before that, besides the vegetable food referred to, the bandeng sometimes even eats cut grass, or at least may sometimes be fed with it; in this connection it is interesting to report Mr. Max H. Th. Görs's statement that if too many bandeng are turned into a pond the animals will devour not only the whole of the aquatic vegetation, but also all overhanging landplants touching the surface of the water, or growing some distance along the pond-bottom (e.g. *Paspalum distichum* L.).

It is doubtless the vegetable diet of the bandeng which accounts for the circumstance already mentioned by THOMAS (8) that the bandeng is not to be caught with animal bait on a hook. "They are such magnificent fish", says THOMAS (8), "that it is a thousand pities they can not be taken with a rod and line. I have tried spinning and fly in vain". I once heard a rather good yarn illustrating this, about a native sailor of a Netherlands East Indian Government Steamer, who could take bandeng with hook and line, because he baited it with a piece of potato. Whether this tale is true I connot say, but a priori it does not seem at all impossible.

I have already mentioned before when dealing with an example taken from the exploitation of Mr. Görs's pond-system near Muara Karang (cf.

Map II), that at Batavia the frequently mentioned "algal"[1])-vegetation composed of *Chaetomorpha* etc. (cf. photos no. 2, 3, 4, 6, 8, 9, 14 and 15; Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII) is allowed to develop again as food for the bandeng [2]) before new fish is turned into a pond which has been cleared of bandeng. I must now add to this that immediately after the catching away of all the fish, and consequently before the water-vegetation is allowed to recover, the water is usually entirely renewed, and if possible the whole pond-bottom is laid dry for a couple of days. This replenishing with new water together with the laying dry of the bottom are effected with a view to the development of the aquatic vegetation in general, therefore of the tay-ayer organisms (Schizophyceae, Diatoms) as well as of the "algal"[1])-vegetation[3]).

Whereas in the vicinity of Batavia most of the Chinese pond-owners and also Mr. Görs, allow the "algal"[1]) vegetation to develop as food for the bigger bandeng, this does not seem to be done in other parts of Java, where the marine ponds belong to the native population. Also the bigger bandeng is then obliged to feed on "tay-ayer" organisms. The development of the "tay-ayer"-organisms is then more or less actively promoted by the more or less regular draining-dry of at least the central part of the pond, when the fish retire to the deeper belt-ditch. In this connection VAN KAMPEN's ([25]) remark is important: "The culture of bandeng (Chanos orientalis) has reached a high degree of development at Batavia". Also TREUB ([30]) says that "the bandeng-culture in salt-water fish-ponds in the neighbourhood of Batavia is on a fairly high level". Personally I am only acquainted with the Batavia empangs situated between Kamal and Tjilintjing. During a very short visit to the tambaks of Pasuruan and Bangil I certainly did not receive the impression, to put it mildly, that these are worked better than Mr. Görs's or the other Batavia sea fish-ponds which are Chinese-owned. It would accordingly appear to me that the method pursued by Mr. Görs and the Chinese empang-owners near Batavia (as also in a few other places by native tambak-proprietors) in which only the young bandeng are fed on "tay-ayer", but the older fish on "algae"[1]), is an improvement on the native method which obliges the bandeng always to feed on "tay-ayer" organisms.

Mr. Görs once told me that the rearing of bigger bandeng with "tay-ayer" and with "algae" [1]) are two different cultures, consequently produc-

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[1]) cf. note page 209.

[2]) In Chapter IV we saw that there are a number of indications tending to make it probable that a luxuriant development of the submerged vegetation is favoured by salinities either lower or but little higher than about 25 ‰. In this place I may be allowed to add that VAN SPALL ([3]) relates how bandeng-rearers of Besuki (p. 36) and Probolingo (pag. 39) are of opinion that those are the best ponds which can be supplied not only with salt water but with fresh water as well; it seems however that VAN SPALL himself does not share this opinion.

[3]) That a strong revival of the "algal"-vegetation also sets in after the ceasing of the heavy west-monsoon showers, i. e. after a natural change in the fish-ponds as biological environment, I have already mentioned in Chapter IV.

ing entirely different fish-products. To this Mr. Görs added afterwards (17 IV '19) that in his opinion the rearing of bandeng without "algae" [1]) is a rather worthless proceeding, to be ventured on perhaps by some Chinese but which he rejected. Also a native bandeng rearer from the neighbourhood of Marunda gave it as his opinion (22 IX '20) that for the efficient rearing of bigger bandeng "algae" [1]) as food were essential. At Batavia I could often ascertain that bandeng fed on "tay-ayer" is distinguished from the "algae" [1])-fed bandeng by a sickly-sweetish earthy taste.

I have already reported the communication made to me by the Chinese land-lord of Tjilintjing, to the effect that the *Chaetomorpha*-vegetation is not at its best as bandeng-food until it comes floating to the surface and grows old and yellow. Several bandeng rearers at Batavia told me the same thing. According to them the bandeng does indeed eat the young lumut kain (= *Chaetomorpha*) when it begins to develop at the pond-bottom, but they do not grow fat on it. When, however, the lumut kain has come to float at the surface and begun to discolour it is more valuable as bandeng food. To this I may add that the "algal" [1])-vegetation to be seen in photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII) is at the stage when according to the bandeng-rearers referred to it is at its best as bandeng-food. The *Chaetomorpha*-threads are then "coated" and the entire vegetation is then overgrown (with *Oscillatoria*, *Gloeocapsa* etc.) as described in Chapter IV. Even the very old *Chaetomorpha*-vegetation which as stated in Chapter IV, sinks to the bottom when the West-monsoon begins to prevail is said by the Batavia bandeng-rearers to be eaten by the bandeng. In the same way the cut (land-) grass thrown into the ponds is said to be eaten by the bandeng after it has rotted more or less and sunk to the bottom.

In connection with the foregoing the question arises whether it would not perhaps be still more correct, instead of calling the bandeng simply a vegetarian, to say that the bandeng feeds on nearly always vegetable, preferably more or less decayed organic matter.

I will briefly quote what is stated in the scant literature on the Java marine fish-ponds concerning the food of the bandeng reared in the tambaks.

VAN SPALL ([3]) on page 27, says: "These islets and likewise the little "walls are planted with shrubs bearing the names of api-api [2]) and "tandjang [3]) and which flourish luxuriantly in sea-water".

"This is done designedly and that with the following objects in the "interest of the culture; first, for the sake of providing shade; secondly, "because the leaves shed by these shrubs rot and form a kind of "manure useful to the ponds; thirdly because numbers of marsh-birds

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[1]) cf. note page 209.

[2]) According to Mr. C. A. BACKER, Botanist for the Java-flora, *Avicennia marina* VIERH. and/or *Avicennia officinalis* L..

[3]) According to Mr. C. A. BACKER *Rhizophora conjugata* L., *Rhizophora mucronata* LAMK. and/or *Bruguiera gymnorrhiza* LMK..

"among which the kuntul [1]) and blekok [2]) are the principal, settle "on these shrubs and the fish prey upon the droppings of those sea-birds, "to which the fatness of the bandeng near Grissee is ascribed; and finally "because these shrubs being thinned out or lopped once or twice a year "sell advantageously as fire-wood". On page 32 VAN SPALL (³) further writes: "The fish in the ponds are not artificially fed; their food consists of "a green vegetable mossy" (sic) "accretion of the bottom, known to the "native by the name of "lumut" (= algae) together with the excrements "of the sea-birds." He finally states on page 48 "that in the neighbourhood "of Semarang the fry. . . . . are sometimes fed with bran".

In "Zeevisscherijen langs de kusten der eilanden" (⁹) (page 12) only part of the passages just cited from VAN SPALL (³) is quoted (not verbatim).

DABRY DE THIERSANT (⁶) only says (p. 86) "Les ikan-bandeng se nour-"rissent de végétaux *(Salvinia? Pistia?)* qui se développent spontanément "dans les réservoirs, et aussi, dit on, des déjections des oiseaux de mer."

In DE JAAGER and VAN LAWICK VAN PABST (¹⁷) on pages 23 and 24 the following passage is met with: "The laying dry of the ponds referred "to above serves a double purpose.

"In the first place this enables one to keep the ponds at a proper "depth as will be further dealt with under the heading "working expenses"; "in the second place it is conducive to the formation of moss and duck-"weed ("kroos") in the ponds. For in fact the presence of vegetable "and animal matter seems to be good for the fishes.

"The same purpose is served by the planting of tandjang [3]), api-api [4]), "duduk [5]) and waru [6]) in the ponds and along the banks and walls; "the dropping of faeces, leaves, dung and other refuse into the ponds; the "cutting and stacking of the grass shooting up in some of the ponds, and "for that purpose also the growth of moss and duck-weed is promoted. "The fish however does not live on the water-plants themselves but only "consumes them when they have perished and begun to decay.

"It is also to furnish them with food in this condition (called "klèkap") "that the draining-dry takes place, for this affords an opportunity of "exposing the aquatic plants to the solar heat and the influence of the air, "thus causing them to die and rot.

"When the pond is subsequently filled with water the fish find their "food in the form in which they can take it. The pond-owners relate "that to this end they" (viz. the fish) "stir up the bottom with their tails, "thus temporarily forcing the klèkap up.

[1]) According to our ornithologist Mr. M. E. G. BARTELS *Garzetta nigripes* TEMM and perhaps also *Herodias alba* L..
[2]) According to Mr. M. E. G. BARTELS *Ardeola speciosa* HORSF..
[3]) cf. note [3]), page 218.
[4]) cf. note [2]), page 218.
[5]) *Lumnitzera racemosa* WILLD..
[6]) *Hibiscus tiliaceus* L..

"Shortly after the letting in of the water duck-weed is formed in nearly "all the ponds if fresh water also can enter, and on a clay-soil if only "sea-water gets in. On soils mixed with sand or gravel the duck-"weed (ganggeng) has more difficulty in developing than on clay, and "does not develop at all unless there is also an admixture of fresh water".

In the "Synopsis of the Section-reports on the results of the inquiries into the pisciculture and fisheries in the Residency of Pasuruan" (Samentrekking van de Afdeelingsverslagen over de uitkomsten der onderzoekingen naar de vischteelt en visscherij in de Residentie Pasoeroean ([19b])) of the "Prosperity-commission" (Welvaart-commissie), page 16 reads: "The produc-"tivity of many ponds has of late years declined, which is attributed by the native "population to the circumstance of the increasing prevalence of a sort of periwin-"kle (tlisipan), sometimes in such masses that they practically cover the "bottom. These shell-fish destroy the little water-plants and fungi growing on "the bottom, on which the fish must feed, or they hamper their growth".

In conclusion VAN KAMPEN ([25]) says concerning the marine fish-ponds in the environs of Batavia: "The fry feed, according to what the rearers say, "on the so called "tay-ayer". This is the same thing as what is called "klèkap" in Javanese, namely a soiled-gray mass consisting of a blue-green "alga (*Oscillaria* sp.). When the little fish have grown to be about 3 to "4 cM. long, they are given every day "lumut" (green algae, *Vaucheria* "sp. and others) chopped fine. Also the older bandeng are fed with algae "brought purposely into the ponds".

With the exception of this last quotation from VAN KAMPEN ([25]), the above quoted passages written by non-biologists, give us little solid information to go by. Moreover VAN KAMPEN's ([25]) statement alone refers to the Batavia empangs. This in fact tallies perfectly with the data collected by myself. Only where VAN KAMPEN ([25]) says that the older bandeng is fed with algae put purposely into the ponds, he mentions an exceptional case; the algae on which the older bandeng feeds have mostly developed on the spot.

Besides "lumut", i. e. green algae, recognizable as such with the naked eye, such as *Chaetomorpha*, *Vaucheria*, *Spirogyra* and *Enteromorpha*, VAN SPALL ([3]) mentions also as a by no means unimportant food for the bandeng, the droppings of sea-birds, and principally of the kuntul [1]) and the blekok [1]), i. e. of herons. At Batavia I have never seen or heard anything about the bandeng eating the excrements of birds. The only remark I can make on this point is, that in October 1920 during a visit of a few hours among the tambaks near Bangil, I was struck with the numbers of the cormorants [2]) and herons which had made this pond-district their haunt. On my frequent excursions through the Batavia empang-district I never saw anything like it.

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[1]) cf. notes [1]) and [2]) page 219.
[2]) According to Mr. M. E. G. BARTELS *Phalacrocorax javanicus* HORSF..

DABRY DE THIERSANT (6) relates that the information contained in his article on Java was furnished to him by Mr. VAN GORKOM "fonctionnaire chargé de la culture des Cinchona à Bandaeng" (sic) "(Java)". That Mr. VAN GORKOM drew his data in his turn from VAN SPALL's article (3) appears from the figures mentioned by DABRY DE THIERSANT (6). However, I cannot tell how DABRY DE THIERSANT (6) came by the names *Salvinia* and *Pistia*, naturally not mentioned by VAN SPALL (3). Both names in fact have been very properly marked with notes of interrogation, which accords well with the fact that the plants designated by those names do not occur in marine ponds, or more generally speaking in brackish water; at least they have so far not been met with [1]).

As regards the afore-quoted passage from DE JAAGER and VAN LAWICK VAN PABST (17), it is very probable in connection with what VAN KAMPEN (25) says, that the definition given in it of "k l è k a p" is not quite correct. VAN KAMPEN (25) says expressly that "k l è k a p" is the same thing as "t a y-a y e r". Therefore "k l è k a p" most probably does not, or at least does not in the first place consist of "partly decayed water plants", but of the "tay-ayer" organisms described in Chapter IV (Schizophyceae, such as *Oscillatoria*, *Lyngbya*, *Nostoc* etc. and Diatoms like *Pleurosigma* etc.).

That VAN KAMPEN (25) is right in this is also highly probable in connection with the following. In the draining of the ponds so as to lay the bottom dry (a. o. to promote the development of the tay-ayer organisms) after a few days the upper layer of that bottom held together by the tay-ayer organisms begins to crack and scale off in flakes. This is a well-known phenomenon regularly to be observed in the marine pond district. Now the Javanese name "k l è k a p" which ought properly to be written "n g l è k a p" or still better "n g l è k è p", as a matter of fact designates this scaling off of the upper layer of the bottom.

Further "g a n g g e n g" is not duck-weed. As I pointed out in Chapter IV, at Batavia (a. o.) *Najas falciculata* R. BR. is called "g a n g g a n g". Perhaps the fault lies with the Javanese dictionary, for in JANSZ' (36) the translation of the Javanese "ganggeng" is found as: a long sort of duck-weed ("kroos"), a trailing water-plant.

It may further be assumed as a well-known fact that no "moss" grows on the bottom of marine fish-ponds. Yet not only DE JAAGER and VAN LAWICK VAN PABST (17) speak of "moss", but also VAN SPALL (3) calls "l u m u t" (i.e. algae) "a green, vegetable accretion of the soil, belonging to the m o s s - s p e c i e s" [2]). In view of the preceding it appears to me very probable that "by moss and duck-weed" DE JAAGER and VAN

[1]) Mr. C. A. BACKER, botanist for the Java-flora informed me that *Salvinia* is distinctly halophobous, and that if *Pistia* should occur in water still containing some salt, this quantity of salt was bound to be minimal.

[2]) Also in JANSZ' Dictionary (36) the translation found for "l u m u t" is: fine moss, accretion, green coating, weed, duck-weed, coral-moss.

LAWICK VAN PABST ([17]) mean the vegetation described in Chapter IV as consisting of algae (*Chaetomorpha*, *Enteromorpha* etc.) and of higher submerged water-plants (*Ruppia rostellata* and sometimes also *Najas falciculata*).

The sentence: "The fish however, does not live on the water-plants "themselves, but only consumes them when they have perished and begun to "decay", is not quite correct, as I frequently had opportunities of observing bandeng most positively eating young, fresh, perfectly living *Chaetomorpha*, *Enteromorpha*, *Vaucheria*, *Najas*- and *Ruppia*-leaves, etc.. But it centainly contains a kernel of truth. For indeed I have already communicated how various bandeng-rearers at Batavia and Tjilintjing told me that the *Chaetomorpha*-vegetation is only at its best as bandeng-food when it has grown "old".

Whatever truth there may be in the story that the bandeng should stir up the pond-bottom with its tail to get food, I would not venture to say. At Batavia I have never heard or seen anything of the kind. Finally there is no occasion for surprise in DE JAAGER and VAN LAWICK VAN PABST ([17]) not knowing the "tay-ayer" organisms. Further I must once more remind the reader that DE JAAGER and VAN LAWICK VAN PABST ([17]) in their statements refer exclusively to the marine fish-ponds east of Kendal, and chiefly to the fish-ponds of Djuwana and Sourabaya.

Also from the passage quoted from the Synopsis of the Section-reports of the Prosperity Commission (Samentrekking van de Afdeelings-verslagen der Welvaartcommissie ([19b])) the main fact ultimately emerges, as from all the other citations, that the food of the bandeng is of a vegetable nature.

§ 4. The Bandeng in the Batavia Empangs.

The bandeng-roe.

The Enemies of the Bandeng living in the Batavia Empangs.

The manner in which the bandeng-fry (usually called at Batavia "ûget", but of course also "bibit[1])-bandeng") is caught in the sea quite close to the shore, has been described by VAN KAMPEN ([27]) (page 73 and 74) in detail and quite correctly. VAN KAMPEN ([27]) mentions that the catching of bandeng-bibit takes place "chiefly during the turns of the monsoons (March-April and September-November)". Hence at Batavia bandeng-rearers will tell one that the new bandeng-fry is planted in the fry-ponds (pembibitan) in the third and ninth Chinese months, i.e. in April-May and in October-November. Elsewhere VAN KAMPEN ([25]) reports: "the great planting of fry . . . in the months of February and March". This is not quite correct; the spring-planting takes place as I have said in April and/or May. VAN KAMPEN ([25])

[1]) bibit (Malay) = brood, seedling.

speaks rightly of the great planting; as a matter of fact more new fry are liberated into the Batavia ponds in the spring-turn than in the autumn-turn.

The "ûget" turned into the Batavia empangs is obtained from the (more or less sandy) beaches of Karang Antu in the bight of Bamtam, Sedari and Tjemara in Krawang, Bobos near Pamanukan, Indramayu, Cheribon, Tegal and Pekalongan. In 1918 Mr. Görs paid about fl. 40.— per 10.000 ûget, and he told me both on May 28th and on October 15th of that year that when the young fry had reached a length of about 10 cM., out of 100.000 to 110.000 ûget there were no more than 40.000 left. On September 24th, 1920 Mr. Görs added that since of late he had not been able to personally supervise his empang-enterprise so well as formerly the number of ûget that had arrived at the length of ten cM. had dropped to about 16.000 out of 110.000.

I have already mentioned that the ûget in the pembibitan (fry-pond) feeds on "tay-ayer" organisms and that the young animals when they have reached a length of 3 to 4 cM. are also sometimes fed with *Enteromorpha* chopped small. The ûget is usually left in the fry-ponds for only $1^1/_2$ to $2^1/_2$ months, after which the young bandeng are generally turned into not too large a pond (pembuyaran) in which there is usually little or no "algal [1])-vegetation" and where the density of the population per area-unit is as a rule greater than in the empangs proper where the fish has to grow big and fat.

In a pembuyaran the young bandeng remains 2, 3 to 4, sometimes 5, and occasionally as long as 12 months, during which the fish mostly attain a length of from 10 to 15 cM. and a weight of between 125 and 250 grammes. Then the fish is transplanted from the pembuyaran into the real empang, where the "algal [1]) vegetation" has been previously allowed to develop. Under favourable circumstances the bandeng may have attained a weight of approximately 1500 grammes after about 5 months' stay in this empang.

Of course it is no wonder that the weights attained by bandeng reared in Batavia empangs after a specified time vary considerably. For the period during which the animals are kept in the pembibitan and pembuyaran, the nature and intensity of the water-circulation within the pond-system, and respectively of the renewal of the water, the size and depth of the ponds, the nature of the pond-bottom, the nature and available quantity of the food, the number of bandeng turned into the pond per area-unit and many other factors help to determine the weight that the bandeng will have attained after a specified time.

Thus in the Pasar Ikan (fish-market) at Batavia I once saw two lots of bandeng, the owner of which asserted that they both consisted exclus-

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[1]) cf. note page 209.

ively of animals which had been bought 14 months before as "ûget" but had been kept in two different ponds [1]).

Of one lot [2]):
the biggest specimen measured 45 cM. (*not* including the caudal fin) and weighed 1700 grammes;
the smallest specimen measured 41 cM. (*not* including the caudal fin) and weighed 1100 grammes.

Of the other lot [3]):
the biggest specimen measured $30^1/_2$ cM. (*not* including the caudal fin) and weighed 525 grammes;
the smallest specimen measured $24^1/_2$ cM. (*not* including the caudal fin) and weighed 300 grammes.

One of the heaviest empang-bandeng that I have personally inspected and weighed, and which I have already mentioned incidentally when dealing with the stomach-contents, was a fish of $\pm$ 8 catties (i.e. nearly 5 K.G.) reared at Tjilintjing. I do not know how old that bandeng was, but I learned at the time that at Tjilintjing bandeng are sometimes allowed to live to the age of 6 years before they are caught.

As regards the density of the population of the empangs, that is, the number of bandeng turned into them per unit of area, I have no reliable data at my disposal. I have tried a few times to estimate the density of the population from information gathered from Mr. Görs's native staff. These estimates concern the population of the empangs proper, therefore not of the pembibitans or pembuyarans, and they vary between 1 bandeng per 8 M^2. and 1 bandeng per 18 M^2.. But I do not attach much value to these estimates.

All the year round a certain quantity of bandeng is marketed at the Pasar Ikan (fish-market) at Batavia. Very large quantities of bandeng, however, are caught every year and sold at the Batavia fish-market during the last two days preceding the Chinese New-Year's day, which as I have stated before always falls on or after January 21st and before or on February 20th. This fish is then sold by middlemen, who have bought them at the Pasar Ikan, to the consumers during the Pasar Malam (= night-market), which is held during the two evenings immediately preceding the Chinese New-Year's day in the lower-town of Batavia.

Photo 13 (Plate XXI) shows something of the way an empang is emptied of all the fish it contains. The method is as follows: Along (i.e. close to and parallel to) each of the short sides of an empang which is oblong-rectangular, a row of fishermen is stationed. The men stand in the pond, in the water, those on one side facing the fishermen visible at

[1]) According to said owner in one of these two ponds floating algal masses had been present, whereas in the other pond "tay ayer" had been the only food available for the bandeng. Of course there may have been yet many other differences between the two ponds.

[2]) from the pond with floating algal masses.

[3]) from the pond without algal vegetation where the bandeng had to feed on "tay ayer".

the other extremity of the pond. Each of the fish-catchers is furnished with a cast-net (djala [1])). Now the two rows of catchers begin to move towards each other, the men wading through the water. Each time a fisherman thinks he sees a bandeng he throws his cast-net; the bandeng if caught is put in a bag which each catcher trails behind him through the water. The bandeng trying to escape from the advancing catchers, are being driven, in so far as they have not yet been caught in the cast-nets, within the ever-narrowing space remaining between the two approaching rows of fishermen. When the two rows have come fairly close together an upright gill-net (djaring [1]) bandeng) is placed vertically in the water behind each row of fishermen for the whole breadth of the pond. The bandeng, breaking through one of the two rows when closely pressed, dashes into either of these gill-nets. The pond to be emptied is usually searched and swept twice in this manner; if this was not done too many bandeng would be left behind in the pond. For it sometimes happens that a few bandeng dodge through the cordon of fishermen before the gill-nets have been put in position; others leap over the gill-net and so make good their escape, temporarily at least.

This sweeping of a bandeng-pond is an exciting scene. Soon after the fishermen have begun to move forward the cast-nets are in action all the time. When the two rows of fishermen have approached nearer and the gill-nets have been suspended behind them, the water between them begins to seethe with the bandeng madly dashing to and fro, their silvery glittering bodies leaping frequently high up above the water. Besides, the diligence of the fishermen is effectively stimulated by the fact that each of them is paid in proportion to the number of fish he has caught.

According to the statements of the Batavia bandeng-rearers the bandeng reared in their ponds never attains puberty. This tallies with the fact that I dit not find any roe in any of the numerous empang-bandeng I could open in the course of years. Mr. E. J. REYNTJES however, the fisheries-expert (visschery-adviseur) at Pasuruan, showed me roe in October 1920, which he stated to have been taken from a five-year-old bandeng from the tambaks near Bangil. Also THOMAS (8) says about the bandeng living in a pond near Cundapur, where the water is only slightly brackish, that "they breed there freely."

Of sea-bandeng I have frequently seen roe. The sea-bandeng, however, in which I could ascertain the presence of roe, were always much bigger than the largest specimens of pond-bred bandeng that I have ever seen. So that considering all this it seems to me not improbable that the pond-reared bandeng is generally too young to contain roe. But as the animals in question are reared in a milieu widely divergent from their natural environment one has to be very cautious in drawing conclusions.

[1]) cf. VAN KAMPEN (27).

On November 14th 1919 I had a chance of examining a female sea-bandeng caught in a sero [1]) (fishing-stakes) in the neighbourhood of Marunda. The animal was 112 cM. long (including the caudal fin) and had a weight of 11.900 grammes. The roe of this animal weighed no less than 1304 grammes. The number of eggs making up a weight of 1 gramme was counted by my assistant, Dr. H. C. DELSMAN, and it proved to be 4370. The whole roe therefore consisted of about 5.700.000 eggs. This is a very large number. The fish in which up to now the greatest number of eggs, viz. up to nearly 9.000.000 has been found is, as far as I know, the cod (*Gadus morrhua* L.). Next follows the sturgeon (*Acipenser sturio* L.), with 3 to 6 million; the halibut (*Hippoglossus vulgaris* FLEM.) with over 3.000.000 and the burbot (*Lota vulgaris* CUV.) with one million eggs.

However not every cod-fish has nearly 9.000.000 eggs. FULTON ([10]) mentions a cod that had less than 3.000.000 eggs. Hence it is not à priori impossible that the bandeng should have on an average nearly as many eggs as the cod.

Beside the absolute number of eggs it is usual to state the number of eggs per pound of weight of the body. The following schedule shows the place which this particular bandeng of 14 XI '19 holds in this respect:

burbot (*Lota vulgaris* CUV.):	500.000	eggs per pound of body-weight
tench (*Tinca vulgaris* CUV.):	300.000	,, ,, ,, ,, ,, ,,
our bandeng of November 14th, 1919:	240.000	,, ,, ,, ,, ,, ,,
carp (*Cyprinus carpio* L.):	100.000	,, ,, ,, ,, ,, ,,
perch-pike (*Lucioperca sandra* CUV.):	100.000	,, ,, ,, ,, ,, ,,
cod (*Gadus morrhua* L.):	90.000	,, ,, ,, ,, ,, ,,

The halibut (*Hippoglossus vulgaris* FLEM.) and the sturgeon (*Acipenser sturio* L.) have respectively only 30.000 and 12.000 eggs per pound of body-weight.

Of the numerous enemies that beset the bandeng living in the Batavia empangs various bandeng-rearers mentioned to me: the andjing-ayer or otter (*Lutra* sp. [2])); the "dûk" (*Haliaëtus leucogaster* GM.?); various king-fishers (chiefly *Alcedo beryllina* VIEILL.); various herons, among which the kundul malam (*Nycticorax griseus* L.) plays an important part; the biawak or minyawak (*Varanus salvator* (LAUR.)); crocodiles; snakes hiding in holes in the banks of the ponds; fish of prey, such as the kakap (*Lates calcarifer* C. V.), the bandeng lelaki (*Elops hawaiiensis* T. REGAN) and the bulan bulan (*Megalops cyprinoides* (BROUSS.)). Of these species of fish the fry of their own accord penetrate into the ponds from the sea (cf. Chapter VIII). Finally also the crabs (*Portunus sp.*) are mentioned by the native fish-rearers as noxious to the bandeng.

[1]) cf. VAN KAMPEN ([27]).
[2]) not *Lutra leptonyx* HORSF..

To the "ûget" (bandeng-fry) the kepala timah (*Haplochilus panchax* (HAM. BUCH.), cf. Chapters VI and VII) is also dangerous. This little fish which is so very common in the Batavia empangs, is accordingly kept very carefully out of the fry-ponds.

Undoubtedly the above list of enemies of the bandeng reared in the Batavia empangs is very incomplete. (see Appendix to Chapter V, page 302).

CHAPTER VI.

The Cyprinodontidae of the Batavia Empangs.

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§ 1. Haplochilus panchax (Ham. Buch.) and Haplochilus javanicus (Blkr.).

Among the fishes which are practically speaking always met with in the marine fish-ponds of Batavia, the first to be mentioned are two species of Cyprinodontidae, viz. *Haplochilus panchax* (HAM. BUCH.) and *Haplochilus javanicus* (BLKR.)[1]) (cf. fig. 14, 15 and 16).

Of these two species the one that is by far the more numerously represented in the Batavia sea-fish ponds is *Haplochilus panchax.* It occurs rarely that standing at the edge of a bandeng-pond one fails to catch

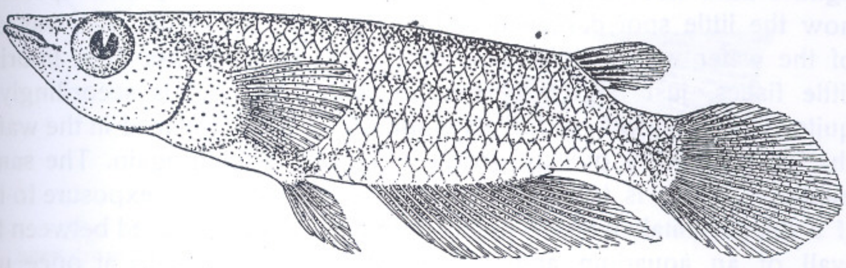

Fig. 14 *Haplochilus panchax* (HAM. BUCH.) from the Batavia empangs, seen from the left side. $\times 2^1/_4$.

sight at once of several specimens of this little fish. The young individuals are frequently seen swimming past in shoals of hundreds. Accordingly I have chiefly turned my attention to this species.

At Batavia and in West-Java generally *Haplochilus panchax* is called "kepala timah"[2]) which might be freely rendered by "the little fish with the white-metallic shining spot on its head." According to GRONEMAN ([24]) the name in Central-Java is "wader tjéto". In JANSZ' dictionary ([36]) I found the name "tjétaq" = "a small river-fish about the size of teri [3]),

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[1]) In BLEEKER's ([4]) Atlas Ichthyologique, *Haplochilus panchax* = *Panchax buchanani* C. V., whilst *Haplochilus javanicus* = *Aplocheilus javanicus* BLKR., For the many other synonyms of *Haplochilus panchax* reference should be made to the systematic literature on the subject.

[2]) kepala = head; timah = lead.

[3]) teri = *Stolephorus* spp,.

but thinner". This may be the same word as GRONEMAN ([24]) means. I have not, however, succeeded in finding out the meaning of tjéto or tjétaq.

The little spot on the head of the kepala timah, which is more or less lozenge-shaped, with a white metallic shine, or sometimes dull like white chalk, is situated above the posterior part of the brain (cf. fig. 15) and it

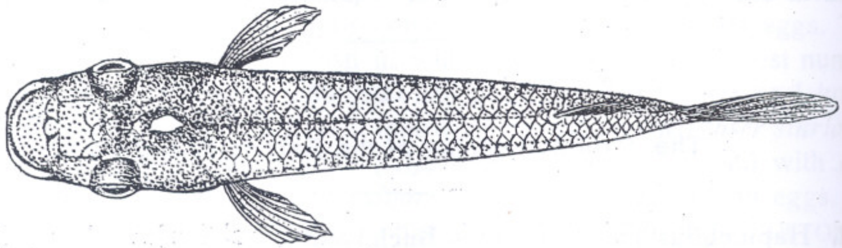

Fig. 15. *Haplochilus panchax* (HAM. BUCH.) from the Batavia empangs, seen from the dorsal side. $\times 2^1/_5$.

can be obscured by pigment cells expanding in the dark and covering over the spot. It has already been described by MIEHE, as also stated in the latest edition of BREHM's Tierleben ([40]).

According to BREHM, MIEHE says that the pigment cells above the little spot which are capable of contraction and expansion only react upon light. I have not made any experiments on this. But I have repeatedly seen how the little spot darkened suddenly when the kepala timah was taken out of the water with a little aquarium net or with a glass dish. In briskly live little fishes, just removed from the water the spot is accordingly always quite obscured even in full daylight. If the fish is placed in the water again the little spot very quickly grows white and shining again. The same thing happens if care is taken to prevent any change in the exposure to the light. If a kepala timah whose spot is shining brightly is placed between the glass wall of an aquarium and a glass dish, the spot dims at once upon the kepala timah being raised along the glass wall by means of the dish until the animal comes to lie dry. On lowering the dish again so as to bring the little fish under water again the spot is seen to turn a clear white again within one or two seconds. Also when the kepala timah made quick sudden movements I sometimes saw the little spot brighten suddenly.

BREHM, or rather STECHE ([40]) in reporting MIEHE's observations speaks of the "blue" *Haplochilus panchax*. Now it is true that in a live kepala timah recently drawn from the water the lower surface of the body on either side of the ventral fins and of the anal fin mostly displays a light-blue or light-violet metallic hue. Also on the gill-covers and behind them, as far as the implantation of the pectoral fins, besides green colours there are also pale-blue or lilac metallic hues to be seen. But it will not do to call the animal itself blue. The dominating colour is green-brown or a brownish green, especially on the dorsal side. BLEEKER ([4])

mentions green only as the chief colouring ("colore corpore viridi"); DAY (7) says "upper surface greenish".

Along the animal's sides this greenish-brown colour especially on the anterior half of the body shades into a metallic green, between which, however, blue may also occur. Behind the ventral fins this metallic green passes on the belly-side into the pale-blue or lilac metallic hue already referred to. The under-surface before the ventral fins and between the pectoral fins is a soiled white.

Along the middle of the back there is often a fine dark longitudinal line stretching from just behind the occipital spot to more or less near the dorsal fin. The proximal extremities of the fore- and hind-edge of the dorsal fin mostly bear one little white spot each, often extending to just on to the back. The free ventral and posterior edge of the operculum is yellow, or sometimes a greenish yellow. The orbits viewed from above are often malachite-green. The iris is golden-yellow with dark spots or an entire dark ring along the outer circumference. BLEEKER (4) already notices that near the edges of the scales the colour of the skin is darker ("colore .... marginibus squamarum profundiore").

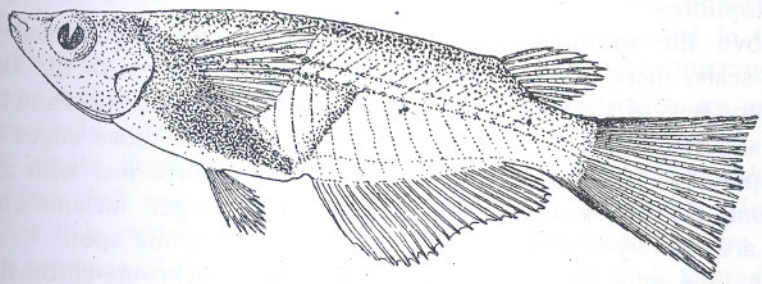

Fig. 16. *Haplochilus javanicus* (BLKR.) from the Batavia empangs, seen from the left side. × 3.

Under the microscope it appears that the skin contains much black pigment along the sunken anterior edge of each scale. In the middle of this black pigment-border is found a more or less markedly developed orange-red spot, especially on the caudal half of the belly-side. The free posterior edge of the glassy transparent scales is not marked by pigment and is consequently not very easy to see. In fig. 14 and 15 it is not really the scales that are traced but only the pigment-lines along the anterior edge of the scales.

A quite correct description of the colours of a fish can really be given only by observing under the microscope how the various colours and hues originate. This can be done with a kepala timah by placing a specimen, immediately after clipping off the head with a pair of scissors, under a binocular microscope and observing it through e.g. the pair of objectives (a_3) and the Huygens' oculars no. 3 of Zeiss.

It then appears that, as is usually the case, the green-brown colour of the back arises from the combined effect of black melanin-chromatophores and yellow lipochrome-chromatophores in the deeper layers of the skin, above which in the more superficial layers of the skin (in the epidermis?) a number of smaller star-shaped melanin-chromatophores occur. Anteriorly, on the snout this superficial layer of small chromatophores is entirely absent.

The fine dark longitudinal dorsal line, if present, results from a local accumulation of chromatophores. Among these chromatophores there also occur on the dorsal side of the kepala timah a few pale-violet-blue and light-green to gold-yellow glistening iridocytes; along the sides the numbers of chromatophores diminish, whereas the iridocytes grow more numerous, their presence effecting the metallic tinges of the sides of the body, of the operculum and of the ventral side of the tail. The white colour of the belly before the ventral fins depends upon the absence of chromatophores and the presence of a dense layer of iridocytes forming the so-called argenteum.

The black bands along the fore-edges of the scales are formed by the bigger deeper-seated chromatophores; the little red patch that may occur in the middle of these pigment bands is an accumulation of red lipochrome-chromatophores.

Above the occipital spot which is situated centrally beneath a large cycloid scale, there occur as regards the chromatophores of the skin, only some very few of the superficial small melanin-chromatophores and these are chiefly situated above the edges of the spot. Above those edges again in the deeper layers of the skin the only chromatophores met with are some lipochrome-chromatophores. The deeper lying larger melanin-chromatophores are entirely absent from the skin over the white spot.

The little spot itself and the melanin- and lipochrome-chromatophores that may obscure it, are situated just under against the completely transparent dorsal investing [1])-bones of the skull, in the exomeninx. The white of the spot is formed by a dense compact layer of iridocytes. This may be observed when a kepala timah is allowed to die on the dry under the binocular microscope; for then the iridocytes making up the spot begin to show metallic colours. One can also open the skull of a kepala timah with a couple of fine needles and remove the exomeninx from the ventral side of the dorsal investing-bones of the skull; the exomeninx then proves to contain black and yellow chromatophores together with numerous iridocytes.

Also in a live *Haplochilus javanicus* the pigment of the exomeninx is clearly distinguishable from the outside. *Haplochilus javanicus* has on the head, immediately behind the eyes and situated just laterally of the sagittal plane touching the eye-ball on the median side, two green and blue metallic hued crescent-shaped patches, whose convexity is turned towards

[1]) investing- or membrane-bone = dekbeen.

*the lateral, and concavity towards the median side. These two crescent-*shaped patches are parts of the exomeninx gleaming through the skin and through the dorsal investing-bones of the skull; they contain besides chromatophores also iridocytes, thus differing from the part of the exomeninx between the patches which contains chromatophores only. Moreover the skin over the crescent-shaped patches holds fewer chromatophores than the skin between them.

In the kepala timah the action of the chromatophores obscuring the white little spot may be observed in the following manner. A live kepala timah is taken out of the water and is placed between a pair of glass or metal blocks in a little glass dish without water under a binocular microscope. Studying the spot for instance through the pair of objectives (a_3) and the Huygens' oculars no. 3 of Zeiss, we see through the skin and the investing bones of the skull that the spot is covered with a dark haze from the expanded chromatophores. Next water is poured into the dish and the dark haze lifts after which the chromatophores are seen lying in the shape of very small contracted circular dots af the upper surface of the white spot.

We must now stop for a moment to discuss the colouring of the fins. It is chiefly by these colours that with the kepala timah one can distinguish the males from the females. This difference is not mentioned in the systematic literature available here: BLEEKER (4), DAY (7) and GÜNTHER (5). It is however well-known that with Cyprinodontidae the males are generally more beautifully coloured than the females.

The kepala timah has the free distal edge of its anal fin coloured a more or less clear red. This red passes proximally into yellow. Under the microscope it is evident, as might be expected, that these colours depend upon the presence of lipochrome-chromatophores. Parallel to the red-yellow band, but more proximally situated, another band may develop which is black and formed by an accumulation of melanin-chromatophores. In the males the red and yellow may be developed much more intensely than is the case in females.

The red-yellow band of the distal edge of the anal fin is as it were prolonged on to the ventral fins, whose morphological anterior edge is likewise coloured red, which red passes into yellow again on the inside. At the distal extremity of the ventral fins these colours may develop more markedly than more proximally. Now the kepala timah usually does not extend the ventral fins fan-like, but on the contrary holds them so that the distal apex of the fore-edge points towards the tail; hence the red band of the anal fin is more or less continued in the red bands of the ventral fins. Also the red and yellow of the ventral fins may be much more intensely developed in the males than in the females.

But there is a fundamental difference in the colouring of the dorsal and caudal fins of males and females. The proximal half of the small dorsal fin in both males and females bears, between the afore-mentioned white later it swam about again quite cheerfully, albeit with the caudal fin stuck together and one of the pectoral fins half-shrunken.

In MENSE's Handbuch der Tropenkrankheiten, Band V (50) and in a publication by WILSON (47) of the Madras Fisheries Bureau, species of *Haplochilus*, among which also *Haplochilus panchax*, are frequently mentioned among the best destroyers of mosquito-larvae and pupae. According to SEYMOUR SEWELL and CHAUDHURI (35) there are among eleven different "Indian fishes of proved utility as mosquito-destroyers", three species of *Haplochilus*, among which *Haplochilus panchax* is "by far the most useful for the purpose of destroying mosquito larvae". It even appeared from comparative experiments that these *Haplochilus* species are even far better mosquito-destroyers than the famous "millions" (*Girardinus* (s. *Lebistes*) *poeciloides* DE FILIPPI) of Barbados.

Further down in the same publication they say: "it is difficult to realise how anyone who has studied the animal" (i.e. three species of *Haplochilus*, among which *Haplochilus panchax*) "in its native haunts, or has watched it feed on the larvae in captivity can avoid becoming convinced that it is or may be a very important factor in the reduction of the numbers of mosquitoes bred in any given area of water".

At the laboratory I found how many kepala timah kept in small aquaria always fall to eagerly on the mosquito-larvae and -pupae on which they are daily fed. With this nourishment a couple of kepala timah lived and grew for a year in a small stopper-jar, and only died at last in consequence of an outward circumstance which had nothing to do with nutrition, and might have been avoided.

In order to ascertain what the kepala timah in the empangs feed on, I have examined the contents of the intestinal tract of a large number [1]) of specimens immediately on their being caught. I regularly found in it:
larvae and pupae of Anophelines,
larvae and pupae of other Culicidae,
larvae of Chironomidae,
Hydroporinae,
water-bugs, especially young *Sphaerodema*'s,
small larvae of Odonates,
little aquatic shell-bearing Gastropods,
Cladocera sometimes in very large numbers,
Copepods,
Gammaridea,
Spiders,
once Nereidae,
and further frequently ants which had probably fallen into the water along the edges of the ponds. The hard skeleton of the head of Anopheline-

[1]) more than a hundred.

larvae is still found in the alimentary canal of the kepala timah when the rest of the body of the larva is already entirely digested.

The Nereidae I found in the fore-part of the alimentary canal [1]) of a large number of kepala timah which had been caught (August 5th 1920) in one and the same pond near Luar Batang. The fore-part of the alimentary canal of these kepala timah was crammed full of the Nereidae to such an extent that the little fish all displayed strongly swollen bellies, so that at first I thought they were ill. In addition to the Nereidae mentioned the fore-part of the alimentary canal of these kepala timah also contained some Gammaridea.

From the above list it is certainly clear that the kepala timah in the empangs feeds on all possible kinds of little and sometimes also somewhat larger (Nereidae) animals living in the ponds, and even on terrestrial animals which like the above-mentioned ants happen to drop into the pond-water.

Judging from the conduct of the kepala timah kept alive in aquaria, I can further entirely concur, as concerns the *Haplochilus panchax*, with the statement of SEYMOUR SEWELL and CHAUDHURI (35) that the *Haplochilus* species feed exclusively on live organisms.

Although the kepala timah is fond of devouring mosquito-larvae and -pupae and also occurs in countless numbers in the fish-ponds, yet the empangs teem with mosquito-larvae and -pupae in those places where the submerged vegetation reaches the surface of the water and also among the overhanging plants touching the water along the edges of the ponds.

This experience entirely confirms that gained elsewhere, summarized in MENSE's Handbook (50) in the following sentence, introducing the discussion of the significance of fish-species devouring mosquito-larvae and -pupae as a malaria prophylacticum: "Fische scheinen für manche Gewässer eine ziemliche Bedeutung zu gewinnen, aber nur, wenn sich kein starker Pflanzenwuchs darin befindet und die Ufer steil ansteigen, da anderenfalls die Larven zuviel Schutz finden."

For a further discussion of this question the reader is referred to Chapter VII.

In his Atlas Ichthyologique BLEEKER (4) says that *Haplochilus panchax* occurs "in fluviis et lacubus".

MAX WEBER (11) in his table concerning the occurrence in the Netherlands East Indian Archipelago of genuine fresh-water fishes, and of sea- and brackish-water fishes also to be met with in fresh water, mentions *Haplochilus panchax* for the fresh water of Java, Sumatra and Borneo.

WILSON (47) only mentions *Haplochilus* species among the mosquito destroyers in fresh water; for salt and brackish waters he only names

[1]) In the fore-part of the alimentary canal of Cyprinodontidae a differentiation into oesophagus and stomach has not yet developed.

Therapon jarbua and *Polyacanthus cupanus* as fishes devouring mosquito-larvae and -pupae.

As far as I am aware it is only SEYMOUR SEWELL and CHAUDHURI (35) who mention the occurrence of *Haplochilus* (*panchax* (HAM. BUCH), *melastigma* MC. CLELL. or *lineolatus* C. V. ?) in brackish water, namely at Port Canning in Bengal.

Now the kepala timah is indoubtedly in its origin a genuine fresh-water fish, which as a matter of fact is true of the whole family of the Cyprinodontidae. Still a number of Cyprinodontidae also occur in brackish water. Moreover the Cyprinodontid *Lebias calaritanus* is known to occur in the salinae of Capodistria, whilst a number of species of the American genus *Fundulus* are known to bear not only with impunity (like the stickle-backs, *Gasterosteus* spp.) the being transferred suddenly from fresh into salt water, but even to bear living in salinities that are higher than those of sea-water. How much the highest salinities that the said species of *Gasterosteus* and *Fundulus* will stand amount to, I have not found mentioned in the literature available here.

For the Batavia empangs I collected a number of rather rough but sufficiently practical data concerning the quantitative occurrence of kepala timah at different salinities. In each observation the salinity was determined and the simultaneous quantitative occurrence of kepala timah noted down, expressed in one of the following six terms: none visible; very few; few; present (in normal numbers); many; very many.

The data collected in this manner have been put together in the schedule of page 237, which has been derived from the observation-table (Table IV).

It appears clearly enough from this schedule that within the limits of the salinities mentioned in it ($6.3\ ^0/_{00}$—$84.6\ ^0/_{00}$) the quantitative occurrence of the kepala timah in the empangs is independent of the salinity.

At the laboratory I have also made a few simple experiments on the power of resistance of the kepala timah against important and especially sudden alterations of the salinity. I first transferred a fairly large number of kepala timah which had been caught for me in the empangs, into water from the Batavia drinking-water supply. The animals hardly reacted upon this and all of them continued alive. A couple of days after I put of these animals living in drinking-water:

a. three specimens in coast-water collected at the sea-shore salinity $25.8\ ^0/_{00}$
b. three specimens in a mixture of sea-water and distilled water: salinity $28.8\ ^0/_{00}$
c. five specimens in sea water: salinity $33.4\ ^0/_{00}$

Especially in the case mentioned sub *c*. the animals shortly after the transference were noticeably less mobile than under normal conditions. They then quietly floated about close to the surface of the water, hardly moving their fins. But a couple of hours afterwards they again behaved quite normally, feeling evidently completely at home again in their new milieu, Occurrence of ***Haplochilus panchax*** (HAM. BUCH.) in the Batavia empangs at different salinities.

None visible	Very few	Few	Present in normal numbers	Many	Very many
38.7 ‰	42.4 ‰	18.7 ‰	6.3 ‰	26.0^5 ‰	19.2 ‰
48.1 ‰	44.2 ‰	19.2 ‰	6.7 ‰	26.2 ‰	39.2 ‰
		20.0 ‰	8.1 ‰	28.7 ‰	39.3 ‰
		20.8 ‰	13.5 ‰	29.8 ‰	43.6 ‰
		30.5 ‰	18.7 ‰	30.2 ‰	49.8 ‰
		32.4 ‰	22.0 ‰	37.4 ‰	
		32.7 ‰	23.0 ‰	37.4 ‰	
		33.5 ‰	23.1 ‰	38.1 ‰	
		38.1 ‰	23.3 ‰	39.3 ‰	
		52.3 ‰	24.2 ‰	39.9 ‰	
		70.7 ‰	25.8 ‰	40.0 ‰	
			26.9 ‰	40.7 ‰	
			28.4^5 ‰	42.1 ‰	
			30.8 ‰	42.4 ‰	
			31.1 ‰	42.8 ‰	
			31.5 ‰	44.6 ‰	
			31.5 ‰	46.5 ‰	
			32.0 ‰	48 9 ‰	
			32.0 ‰	52.2 ‰	
			32.2 ‰	54.8 ‰	
			33.2 ‰	75.6 ‰	
			36.2 ‰		
			38.3 ‰		
			41.3 ‰		
			43.6 ‰		
			44.6 ‰		
			46.9 ‰		
			47.6 ‰		
			48.5 ‰		
			54.1 ‰		
			57.8 ‰		
			84.6 ‰		

and they eagerly ate the mosquito-larvae and -pupae with which they were fed.

Of the animals mentioned sub *c.*, living in seawater of 33.4 ‰, I transferred two, a couple of days later, into distilled water prepared in my laboratory. Also in this case the animals were far less mobile than in normal circumstances, though only for a short time after the transference. But instead of floating at the surface, this time they rested with their bellies on the glass bottom of the aquarium filled with distilled water, into which they had been put. Yet the animals soon behaved quite normally again. A couple of days after, I transferred these same kepala timah back again from the distilled water to the seawater of 33.4 ‰. This also they bore well, all five of them.

Next I again conveyed 10 kepala timah from fish-pond water of 27.8 ‰ salinity into distilled water, in which again the animals soon appeared to be feeling at home.

Hereupon I made some experiments on the transference of kepala timah from distilled water into water of a higher salinity than that of seawater. For this purpose I drew about two pints of pond-water of a high salinity by means of a waterjet suction-pump through some filter-candles. The pond-water thus purified proved to have a salinity of 62.9 ‰ (determined by means of a KÜCHLER areometer and a thermometer after diluting one weight-part of this water with one weight-part of distilled water). By mixing this water with smaller or larger quantities of distilled water, solutions of different concentrations were obtained.

The fish then transferred were:

a. 2 kepala timah from distilled water into water of a salinity of 62.9 ‰
b. 3 „ „ „ „ „ „ „ „ „ „ 52.4 ‰
c. 3 „ „ „ „ „ „ „ „ „ „ 41.9 ‰.

All these animals died within a few hours. Only one of those mentioned sub *b* did not die till a little more than 24 hours later.

From the above it therefore results that in my laboratory kepala timah drawn from the Batavia empangs, after living a couple of days in distilled water:

d i d bear being suddenly transferred from distilled water to water of a salinity of 33.4 ‰ or less, together with being inversely conveyed back again suddenly into distilled water;

d i d n o t bear being suddenly transferred from distilled water into water whose salinity amounted to 41.9 ‰ or more.

Afterwards I also put a number of kepala timah from pond-water wherein they were living naturally when caught and whose salinity amounted to 27.8 ‰ into solutions of different salinities. The result of this is synoptically tabulated as follows:

	Each time one kepala timah transferred from water of a salinity of 27.8 $^0/_{00}$ into:					
	aqua dest.	31.45 $^0/_{00}$	41.9 $^0/_{00}$	52.4 $^0/_{00}$	62.9 $^0/_{00}$	62.9 $^0/_{00}$
within 24 hours					dead	dead
after 1 × „ „	remained alive.					
„ 2 × „ „		41.9 $^0/_{00}$	52.4 $^0/_{00}$			
„ 3 × „ „				57.6 $^0/_{00}$		
„ 4 × „ „		52.4 $^0/_{00}$	57.6 $^0/_{00}$			
„ 5 × „ „				dead		
„ 6 × „ „		57.6 $^0/_{00}$	62.9 $^0/_{00}$			
„ 7 × „ „						
„ 8 × „ „						
		together in ± 60 $^0/_{00}$, remained alive.				

The kepala timah that died upon being thrown into too concentrated fish-pond water, before expiring showed the following symptoms:

The animals which were conveyed from distilled water into water of 62.9 $^0/_{00}$ salinity immediately floated about at the surface of the water, quite motionless, and that so high that part of the back from just behind the occipital spot to a little before the dorsal fin stuck out of the water. The dorsal and anal fins were not spread upright, but lay half folded down. The usual motion of the pectoral and caudal fins, which can always be observed, as described above, in a normal kepala timah standing still, was absent, the only motion observable being that of respiration. The occipital spot was not quite, but very considerably obscured.

Sometimes the little animals so to say returned to life spasmodically: the normal movement of the pectoral and caudal fins was then exhibited for a short while, and the occipital spot brightened at once. But soon the motion of the fins dwindled, the spot also dimming again. After a while the little fish turned over and floated belly-upwards, upon which they soon died.

These observations recall those of ISSEL (cf. NUSSBAUM-KARSTEN-WEBER (39) pag. 501); this investigator observed on the Ligurian coast, how the Copepod *Harpacticus fulvus* fell into a lethargic condition as the concentration of the sea-water increased. This would keep on for days together; the animal only awaking from its lethargy when the concentration of the water had sufficiently decreased again. Also on transferring the aforesaid Copepod into freh water ISSEL saw a similar condition of lethargy developing, in this case however of a temporary nature. I have already communicated above that a strong temporary decrease is observable in the livelines and mobility of the kepala timah upon its being transferred from sea-water (in our case of a salinity of 33.4 $^0/_{00}$) to distilled water.

The three kepala timah from the last little table given above, which had been transferred from water of a salinity of 27.8 ‰ into water of a salinity of 52.4 ‰ or of 62.9 ‰, tried by all possible means to get out of the concentrated solution, before the lethargic condition set in. They repeatedly swam slantingly downward against the glass bottom of the aquarium trying to escape into the depth. They would also jump clear of the water and frequently landed outside the aquarium on the dry.

It already follows from what I stated above, concerning the transferring of these little fish from distilled water to sea-water of a salinity of 33.4 ‰, that the lethargic state is not always followed by death in the kepala timah. In proportion as the difference of salinity is greater, between the water in which the animals first lived and that to which they were subsequently transferred, the lethargic state is developed in a more marked degree. If this difference of salinity becomes too great, the lethargic stage is followed by death, but as long as the difference is not so wide, the animal re-awakes pretty soon from its lethargy and soon after behaves quite normally again. When the lethargic symptoms only develop to a slight degree, the occipital spot does not grow dim; this happens only in bad cases like those described above, which were lethal.

Soon after the transference of kepala timah from water of a lower into water of a higher salinity, the little animals appeared to be coated with a white wax-like layer, especially at the mouth, tail and belly-side of the body. I have not tried to ascertain to what this phenomenon was due, but one is inclined to think of an increased mucous secretion of the skin.

In conclusion I ascertained how long the two animals from the last foregoing table, which after 8×24 hours had got into fishpond water of a salinity of 60 ‰, could stand the gradually continued concentration of this water by evaporation. With a view to this the aquarium that was their abode was occasionally exposed to the sun and all the time as much as possible to draughts of air. The result was that 15 days after this had begun one of the animals sprang out of the aquarium then standing in the sunlight, which was not perceived at once, so that the animal met its death on the dry. I have already remarked before that I also observed this jumping out of the water, on the kepala timah being suddenly cast into water whose salinity deviated considerably though not too much from that of the water they had been living in before being transferred.

The aquarium with the remaining kepala timah was now covered over with metal-gauze so as to prevent the animal from leaping out. A couple of days later there were signs that also this little fish began to fare worse. It hardly ate and became ever less mobile, till at last it just floated about listlessly at the surface, hardly moving its fins. At this stage, as has been described before, part of the back emerged from the water whilst the edges of the caudal fin and of one of the pectoral fins assumed a shrivelled and withered appearance.

Twenty-two days after the evaporation of the water had been started I found the animal dead in the morning. It was then however no longer afloat but was couched on its belly and on the laterally spread pectoral fins, entirely shrunk and shrivelled up, at the bottom of the water, the salinity of which then proved to be 108.2 ‰ [1]). The permeability of the skin had evidently increased to such an extent when death had set in that a large quantity of water could be drawn from the animal's body by the strong salt-solution forming its milieu. It is therefore proved that the kepala timah can bear a gradual increase of the salinity of its milieu up to at least 108 ‰.

Between the limits on the one hand of the salinity of the water of the Java-Sea and on the other of that of fresh (even distilled) water, the kepala timah will furthermore bear all possible sudden transitions in the matter of salinity. The remark of SEYMOUR SEWELL and CHAUDHURI (35), that *Haplochilus panchax*, *melastigma* and *lineolatus* "if the process is carried out sufficiently slowly, can be acclimatised to live in brackish water, etc.", must accordingly as far as regards *Haplochilus panchax* be very certainly relieved of the restriction spaced out here.

As regards *Haplochilus javanicus*, which as it appears to me corresponds in many respects with *Haplochilus melastigma* (MC. CLELL.), mentioned by SEYMOUR SEWELL and CHAUDHURI (35), the said restriction may perhaps be correct. *Haplochilus javanicus* is not only smaller and of slighter build than *Haplochilus panchax*, but it moreover seems to me to possess less power of resistance than the latter species in various respects.

§ 2. The eggs and embryos of Haplochilus panchax (Ham. Buch.) and Haplochilus javanicus (Blkr.).

As is already remarked by DAY (7), *Haplochilus panchax* has eggs, which in proportion to the dimensions of the animal's body, are very large. This tallies with the fact that the kepala timah is originally a genuine fresh-water fish.

"Der Laich wird einzeln an Wasserpflanzen abgesetzt und sofort befruchtet" is all that BREHM (40) remarks concerning the eggs of *Haplochilus* species.

SEYMOUR SEWELL and CHAUDHURI (35) only mention that the female of *Haplochilus melastigma* (MC. CLELL.) is known to carry her eggs about with her in clusters of 30 to 36, attached to the abdomen, behind the ventral fins.

I soon found the eggs of *Haplochilus panchax* (fig. 17—21) both in the empangs and in the aquaria in which I kept the live kepala timah. In both cases the eggs were attached to *Chaetomorpha*-filaments. The

1) Determined by means of two KÜCHLER-areometers carefully cleaned of grease, after diluting one weight-part of the filtered salt solution with three equal weight-parts of distilled water. The result was $4 \times 26.94 = 107.76$ ‰ and $4 \times 27.16 = 108,64$ ‰, 108.2 ‰ being the average between these two.

attachment is effected by means of long adhesive threads forming part of the egg-membranes. The eggs are globular, but the diameter is not always exactly equal in all directions. Below will be found the maximum and minimum diameters of a number of live eggs, artificially fertilized twice twenty-four hours before they were measured:

1.43 — 1.52 m.m.
1.45 — 1.50 m.m.
1.45 — 1.55 m.m.
1.48 — 1.57 m.m.
1.50 — 1.50 m.m.
1.50 — 1.52 m.m.
1.50 — 1.53 m.m.
1.50 — 1.55 m.m.
1.50 — 1.55 m.m.
1.50 — 1.55 m.m.
1.50 — 1.60 m.m.
1.50 — 1.60 m.m.
1.52 — 1.60 m.m.
1.55 — 1.58 m.m.
1.55 — 1.60 m.m.

We may therefore say that the average diameter of the kepala timah egg is about $1^1/_2$ m. m.. The smallest diameter measured was 1.43, the largest 1.60 m. m..

It should be remembered that these are dimensions of eggs spawned in brackish or even in salt or very salt water by fishes which had also grown up in similar water. It is not beyond the bounds of possibility that the eggs of kepala timah that have always lived in fresh water and also spawned in fresh water, may be larger. For indeed there are examples of fish-species, such as the plaice *(Pleuronectes platessa* L.) in the Baltic, whose eggs are larger according as the salinity of the milieu is lower.

The kepala timah egg, as may be seen in figures 17—21, always possesses a large number of oil-globules which never unite into one larger globule. When not too weakly magnified the egg-capsule displays a number of fine dots. Furthermore it is surrounded on the outside by the long adhesive-threads already mentioned. With the eggs still lying in the ovarium these adhesive threads are curled up closely against the egg-capsule, as is reproduced in figure 17. In a certain place the threads display a radiate arrangement as is noticeable not only in figure 17 but also in the figures 18, 19 and 20.

Now the egg of the Teleostei is often provided with two envelopes, viz. an internal egg-membrane or zona radiata (= egg-capsule, W. HIS [8a]) and an external egg-membrane or zona villosa (= "Zottenschicht"; cf. O. HERTWIG, Handbuch [20]). The two membranes together are sometimes called chorion, to express that they are supposed to be secondary egg-membranes i. e. egg-membranes formed by the epithelium of the ovarian ovisacs (follicle-epithelium). Others however, are of opinion that the egg-membranes of the Teleostean fishes are formed by the egg-cell itself and ought therefore to be looked upon as primary egg-membranes.

Fig. 17. Egg (with an adhering cluster of unripe ova) prepared from a fresh ovary of a kepala timah (*Haplochilus panchax* (HAM. BUCH.)) from the Batavia empangs. Adhesive threads yet forming a closed layer adpressed to the zona radiata or inner egg-membrane. × 26.

The zona radiata derives its name from the possession of numerous radially arranged very fine canals, which when looked at from the surface of the egg-capsule present themselves as the fine dots referred to above. The zona villosa is absent in many Teleostei. Where present it mostly has the function of an adhesive organ.

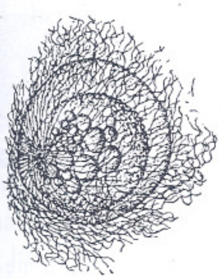

Fig. 18. Egg prepared from a preserved ovary (formol-pondwater 1 : 19) of a kepala timah (*Haplochilus panchax* (HAM. BUCH.)) from the Batavia empangs. × 15½.

Now it is well-known that in the Scombresocidae the villi, of which the zona villosa is built up, are modified into long, vermiform crinkled threads mostly occurring throughout the entire surface of the zona radiata, but which are found only around the micropyle in *Belone*, where they are shorter (cf. O. HERTWIG ([20])). In connection with this, and especially since the Scombresocidae are so closely related to the Cyprinodontidae, I think I ought not only to look upon the long adhesive threads of the eggs of *Haplochilus panchax* likewise as modified villi, but also to assume it as probable that at the spot round which occurs the radiate arrangement of the adhesive threads the micropyle of the *Haplochilus panchax* egg is situated. So far however, I have not had an opportunity of verifying this.

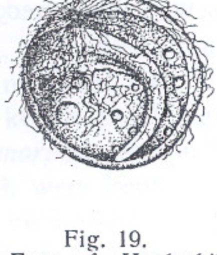

Fig. 19. Egg of *Haplochilus panchax* (HAM. BUCH.) found attached to *Chaetomorpha*-filaments from the Batavia empangs. × 15.

Fig. 18 represents an egg prepared from an ovarium preserved in formol-pondwater 1 : 19. In this egg the adhesive threads no longer form the closed layer adpressed to the zona radiata, as is the case in the egg of fig. 17, prepared from a fresh ovary.

In kepala timah eggs spawned a couple of days before, as e. g. the egg of fig. 20, it is visible how in the spot where the radiate arrangement of the adhesive threads was perceived, these threads are

Fig. 20.
The same egg as represented in fig. 19, only 24 hours older. × 15½.

firmly attached to the zona radiata by the thickened proximal end, as appears when using higher powers.

Outside this spot there are but few adhesive threads fastened here and there to the remaining exterior surface of the zona radiata. The question whether there are originally more adhesive threads attached to the zona radiata, and whether any adhesive threads are formed which are loose from the zona radiata right from the beginning, could only be settled by studying the development of the adhesive threads by means of sections through ovaries.

In fig. 20 is represented the same kepala timah egg as in figures 19 and 21, which was found in a tuft of *Chaetomorpha* from one of the empangs. The egg was youngest when fig. 19 was drawn; fig. 20 was drawn the next day and fig. 21 six days later again. The single long hair of fig. 21 really consists of several adhesive threads twirled into one string. In order to see the egg better the draftsman before doing fig. 21 had removed the remaining adhesive threads still surrounding the egg and between which impurities had collected, with a pencil-brush.

Fig. 21. The same egg as represented in figures 19 and 20, however respectively 7 and 6 times 24 hours older. × 17¾

Fig. 22 shows how the eggs may be fastened to algal filaments by means of the adhesive threads. The eggs drawn in this figure 22 are not, however, eggs of *Haplochilus panchax*, but of *Haplochilus javanicus* (BLKR.). The eggs of the latter little fish are for one thing smaller than those of the kepala timah. In the following list will be found the largest and the smallest diameter of a number of eggs of *Haplochilus javanicus* (BLKR.) fertilized a few hours before they were measured.

1.00 — 1.00 m.m.
1.00 — 1.00 m.m.
1.00 — 1.03 m.m.
1.00 — 1.04 m.m.
1.00 — 1.04 m.m.
1.00 — 1.06 m.m.
1.01 — 1.03 m.m.
1.02 — 1.04 m.m.
1.02 — 1,04 m.m.
1.02 — 1.05 m.m.

1.02 — 1.05 m.m.
1.03 — 1.03 m.m.
1.04 — 1.04 m.m.
1.04 — 1.06 m.m.
1.05 — 1.05 m.m.
1.05 — 1.07 m.m.
1.05 — 1.08 m.m.
1.05 — 1.08 m.m.
1.05 — 1.10 m.m.
1.05 — 1.10 m.m.
1.06 — 1.10 m.m.
1.06 — 1.10 m.m.
1.06 — 1.10 m.m.

The average diameter is therefore about 1.05 m.m.; the greatest being 1.10 and the smallest 1.00 m.m.. Also about these dimensions of eggs of *Haplochilus javanicus* I would emphasise the circumstance that they relate to eggs spawned in brackish or salt water by animals grown in such water.

In the second place the eggs of *Haplochilus javanicus*, at least after they are a couple of hours old, contain only one oil-globule, as may be seen in fig. 22 and 24 to 30. It is only during the first few hours after they have been spawned that they contain a number (some 5 to 10) of small oil-globules (cf. fig. 23), which however unite into a single globule within a few hours.

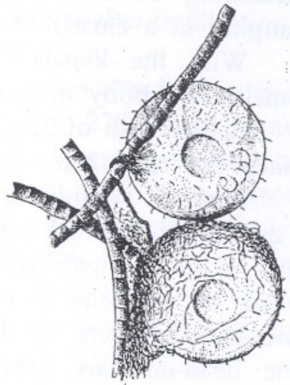

Fig. 22. Eggs of *Haplochilus javanicus* (BLKR.) attached to *Chaetomorpha*-filaments from the Batavia empangs. × 18.

Thirdly the egg-capsule of *Haplochilus panchax* bears two kinds of modified villi. In a certain place which evidently corresponds with the place where the adhesive threads of the kepala timah egg display a radiate arrangement, the egg-capsule of *Haplochilus javanicus* also bears long adhesive threads. Outside this place however a number of short thread-like more ore less hooked processes occur (see fig. 22—30), which are implanted and dispersed on the rest of the zona radiata, and which should undoubtedly, like the adhesive threads, be regarded as modified villi.

Higher up I already mentioned my finding the kepala timah eggs attached to algal filaments, especially threads of *Chaetomorpha*, both in the empangs and in the aquaria in which live kepala timah were kept. The eggs of *Haplochilus javanicus* I found under the same circumstances and attached in the same manner. Moreover my amanuensis, Mr. E. C. A. HERBST, soon after discovered how a female *Haplochilus javanicus* kept in a small aquarium with some other male and female representatives of the same species had a cluster of eggs hanging from the genital opening. When my attention had once been drawn to this I afterwards frequently saw female *Haplochilus javanicus* swimming about bearing clusters of eggs about the genital opening.

But these egg-clusters invariably disappeared soon, i. e. a couple of hours after their presence had been noted. Examination of the eggs still hanging down from the genital opening of the female always showed, that these eggs had only just begun to develop, i. e. they were at the stage represented in fig. 23. Older eggs a little more developed I only found among the algae. I have not had the opportunity to make out whether the eggs simply happen to get entangled here and there among the algae, or whether the females actively try to transfer the eggs to the algal filaments.

As reported before, SEYMOUR SEWELL and CHAUDHURI ([35]) also mention that the female of *Haplochilus melastigma* (MC. CLELL.) is known to carry her eggs about with her in clusters of 30 to 36 attached to the abdomen behind the ventral fins. On a female *Haplochilus javanicus* measuring 31 m.m. (inclusive of the caudal fin), I once counted 24 eggs, hanging in a cluster from the genital opening.

With the kepala timah this carrying along of eggs already produced outside the body does not occur.

In the case of *Haplochilus panchax* it is not difficult to fertilize artificially the eggs taken from a female, so that they develop normally.

Females bearing ripe eggs are recognized when looked at from above, i. e. from the dorsal side, by the bulging of the flanks behind the pectoral fins. Such a female is laid on her back on a towel and then held by the head between the thumb and index of one hand and by the tail between the same fingers of the other hand. Next the thumb and index holding the head-end are moved along the animal's sides towards the genital opening, gently pressing the body. Upon this the eggs, in the first place the ripe ones, will spring from the genital opening. These eggs which by their adhesive threads stick to everything should then be taken from the genital opening, with a fine pincette and deposited in a clean dry china bowl.

Next one takes a big male in which the clear blue colour on the caudal and dorsal fin has completely developed, also squeezes it in the manner described above and then passes the genital opening of the male a few times over the eggs still lying dry in the china bowl. Then water is poured into the bowl with the eggs. I always took for this the water in which the animals had lived whose eggs and seminal fluid had been used.

After five minutes this water was again poured off from the eggs and replaced by another quantity of the same water. This renewing of the water I repeated once again after another five minutes. Upon this I separated the eggs which were clinging together by their adhesive threads, by means of a couple of needles under the binocular microscope, and I put them in a low glass dish with water, placing them among a few fresh *Chaetomorpha*-threads. This glass dish was covered over with a glass cover and the whole was then placed well in the light, but not in the sunshine.

Not all artificially fertilized eggs could be made to hatch in this way. This would however seem to me to be due chiefly to the circumstance that by squeezing a female fish it is also made to yield immature ova.

To quote an example from my notes, I find that out of 23 *Haplochilus panchax*-eggs artificially fertilized in the above manner on August 23rd 1919, eleven did not develop, and 12 did. Of these latter 12 eggs artificially fertilized on August 19th 1919, between 11.30 and 11.40 a. m. there came out:

8 between 27 VIII '19, 1 p. m. and 28 VIII '19, 9.45 a. m.,
i. e. in 8 to 9 times 24 hours after fertilization;
2 between 28 VIII '19, 1 p. m. and 29 VIII '19, 8 a. m.,
i. e. in 9 to 10 times 24 hours after fertilization;
1 between 29 VIII '19, 1 p. m. and 30 VIII '19, 7.50 a. m.,
i. e. in 10 to 11 times 24 hours after fertilization;
1 between 1 IX '19, 1 p. m. and 2 IX '19, 7.50 a. m.,
i. e. in 13 to 14 times 24 hours after fertilization.

Furthermore I found in the morning of January 27th 1920 in an aquarium in which mature kepala timah were living, 4 eggs attached to *Chaetomorpha*-threads. From the stage of development they were in (see below) it appeared that they had been fertilized a few hours previously. Of these 4 eggs fertilised in the morning of January 27th 1920:

2 came out between 4 II '20, 1 p. m. and 5 II '20, 8 a. m.,
i. e. between 8 and 9 times 24 hours after fertilization;
and 1 came out between 5 II '20, 1 p. m. and 6 II '20, 8 a. m.,
i. e. between 9 and 10 times 24 hours after fertilization.

Of the 4th egg the embryo died between 5 II '20, 1 p. m. and 6 II '20, 8 a. m. within the egg-capsule.

From the above it appears that under the circumstances described by me, most of the young *Haplochilus panchax* come out of the egg-capsule more than 8 and less than 9 times 24 hours after fertilization. In the above mentioned cases this never took place earlier, but sometimes up to 5 times 24 hours later.

A young kepala timah just out of the egg-capsule is represented in fig. 31.

When I continued to watch the kepala timah eggs artificially fertilized in the above-described manner, under the binocular microscope, from the beginning, I saw in the first place, how after the eggs had just been impregnated and got into the water a space began to form in the well-known way between the oosperm and the egg-capsule, whilst the formative yolk began to protrude from the globular nutritive yolk, in the shape of a little prominence or rounded cap flattened at the outer surface. In this cap of the formative yolk the first, meridional cleavage took place within the hour; $1^3/_4$ hours after fertilization also the second cleavage had been completed; $2^1/_2$ hours after the fertilization the next two cleavages took place thus completing the third stage of segmentation, whilst finally about $3^1/_2$ hours after fertilization the 5th and 6th cleavages completed also the 4th stage of segmentation and the germinal disk then consisted of 16 cells. About two or three times 24 hours after fertilization the heart begins to beat and the circulation of the blood may be clearly observed. At that time the embryos also already begin to faintly beat their tails.

When the embryos are a few days older they continually wave the pectoral fins and the caudal fin. These fanning movements generally grow stronger as the embryos grow older. Furthermore the older embryos often turn round within the egg-capsule by one blow of the tail. Probably all these movements subserve the exchange of gases. It is a comical thing to see the older embryos, watched through somewhat higher powers (e.g. through the binocular microscope of Zeiss with the pair of objectives (a_3) and the Huygens' oculars no. 3) suddenly roll their big eyes in a skittish frightened way, often looking at the observer with an inimitable squint.

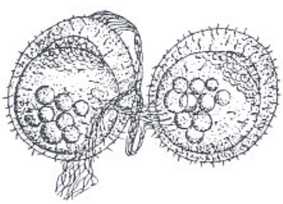

Fig. 23. Two specimens from a cluster of eggs found hanging by the genital opening of a female *Haplochilus javanicus* (BLKR.) from the Batavia empangs, living in an aquarium. Fertilization took place but a few hours ago. Oilglobules not yet united into a single globule. × $16^1/_2$.

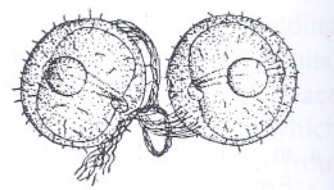

Fig. 24. The eggs of fig. 23, a little more than 24 hours after fertilization. × $16^1/_2$.

As to the period of incubation of the eggs of *Haplochilus javanicus*, I have the following data at my disposal. On a female *Haplochilus javanicus* living in an aquarium a cluster of eggs were found hanging from the genital opening (November 11th, 1919), which eggs on being removed from the genital opening, proved to be in possession of a number of oil-globules, not yet united into a single globule. Furthermore all these eggs showed a germinal disk consisting of hardly more than 32 cells. In connection with what was communicated above concerning the time required in *Haplochilus panchax* after fertilization before the first, second and following segmentations take place, I think I am warranted in concluding that the fertilization of these *Haplochilus javanicus* eggs had taken place but a few hours before they were perceived. Moreover, seeing the animals were fed and observed every morning, it may be considered

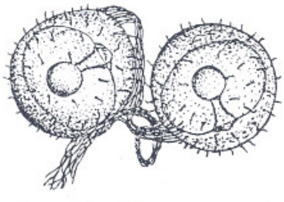

Fig. 25. The eggs of fig. 23 and 24 a little more than 2 times 24 hours after fertilization. × 17.

virtually impossible that the eggs should have been laid or rather produced outside the body before the afternoon of the previous day.

These eggs, therefore fertilized early on the morning of November 11th 1919, I laid apart in a glass dish with pond-water and *Chaetomorpha*-threads, as was described above for the artificially fertilized eggs of *Haplochilus panchax*. On the same November 11th 1919, fig. 23 was drawn from two of these eggs. The next morning, i.e. a little more than 24 hours after fertilization, these two eggs presented the appearance of fig. 24. As is proved by this latter drawing the oil-globules had at that time united into one bigger globule. The figures 25, 26, 27, 28, 29 and 30, were drawn 2, 3, 4, 5, 6, 7 and 8 times 24 hours respectively after fertilization, after the same two eggs.

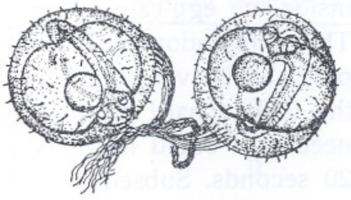

Fig. 26. The eggs of fig. 23—25, a little more than 3 times 24 hours after fertilization. × 18.

At 8 o'clock in the morning of November 21st, it finally appeared that between that moment and 1 p. m. on the previous day, i.e. more than 9 but not more than 10 × 24 hours after fertilization, the first two of these eggs had come out. By an accident the other unhatched eggs were lost that day.

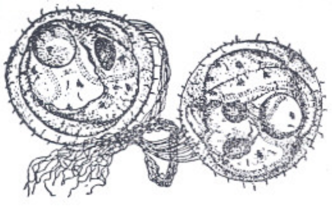

Fig. 27. The eggs of fig. 23—26 a little more than 4 times 24 hours after fertilization. × 18.

Two months before, September 17th 1919, I had however also taken twenty eggs from the genital opening of a female *Haplochilus javanicus*, and placed them in a glass dish with *Chaetomorpha*-threads. From the stage of development they had reached they had doubtless been fertilized early that morning. All these eggs disclosed between about 10 and 13 times 24 hours after fertilization.

From the above it is deducible that the development within the egg-capsule lasts a little longer for *Haplochilus javanicus* than for *Haplochilus panchax*, say about 24 hours on an average.

In conclusion I have another peculiarity to mention which was observed in the embryos still enclosed in the egg-capsule of *Haplochilus panchax*. While studying through a binocular microscope a kepala timah egg found in a tuft of *Chaetomorpha* brought from the Batavia empangs, I noticed that, on my accidentally pushing against the table on which stood the binocular microscope, the heart of the already advanced embryo contained in the egg-capsule suddenly stopped and did not begin to beat again till 10 or 20 seconds later, very slowly at first but gradually more quickly.

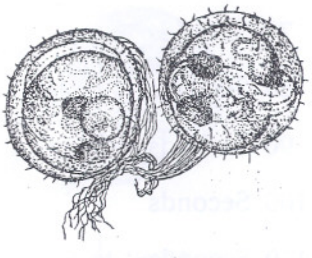

Fig. 28. The eggs of fig. 23—27 a little more than 6 times 24 hours after fertilization. × 18.

When this embryo was perfectly quiet the heart beat 140 to 143 to the minute. On the slightest disturbance however the number of heart-beats instantly decreased. Thus I counted in a minute when a Copepod swam against the egg, 132 beats only, and in a minute when a door banged in the distance 138 beats. Also when the embryo turned about inside the egg-capsule the number of beats regularly declined to 139 a minute. This diminution of the number of pulsations was always due to the heart stopping, be it ever so short a while, upon the disturbances mentioned. By giving the table a hard push or by moving the eggs to and fro with a couple of needles, I could however cause the embryo's heart to stop for as many as 20 seconds. Subsequently the heart began to pulsate again, slowly at first and gradually more quickly, as may appear from the following two tables:

FIRST EXPERIMENT.

Moment of Time	Consecutive number of the heart-beat synchronizing with the moment of time marked in the first column.	Number of pulsations in 10 seconds.	Number of pulsations per minute. (In the perfectly undisturbed embryo 140—143.)
0 Seconds	heart arrested by moving the egg to and fro with two needles.		
10 Seconds	0	0	0
20 Seconds	1	1	6
30 Seconds	4	3	18
40 Seconds	12	8	48
50 Seconds	21	9	54
60 Seconds	33	12	72
70 Seconds	46	13	78
80 Seconds	63	17	102
90 Seconds	83	20	120
100 Seconds	103	23	138
110 Seconds	124	21	126
120 Seconds	146	22	132
130 Seconds	169	23	138
140 Seconds	193	24	144

SECOND EXPERIMENT.

Moment of Time	Consecutive number of the heart-beat synchronizing with the moment of time marked in the first column.	Number of pulsations in 10 seconds.	Number of pulsations per minute. (In the perfectly undisturbed embryo 140—143.)
0 Seconds	heart arrested by moving egg to and fro with two needles.		
		0	0
10 Seconds	0		
		1	6
20 Seconds	1		
		3	18
30 Seconds	4		
		9	54
40 Seconds	13		
		10	60
50 Seconds	23		
		14	84
60 Seconds	37		
		14	84
70 Seconds	51		
		18	108
80 Seconds	69		
		21	126
90 Seconds	90		
		24	144
100 Seconds	114		

On other kepala timah eggs the influence of disturbances proved to be less than on the first egg on which I made the above observations.

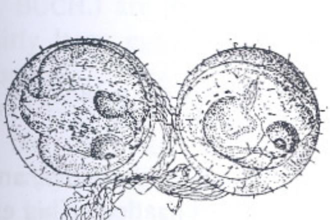

Fig. 29. The eggs of fig. 23—28 a little more than 7 times 24 hours after fertilization. × 19.

Fig. 30. The eggs of fig. 23—29 a little more than 8 times 24 hours after fertilization. × 20.

Thus an experiment on an artificially fertilized kepala timah egg, which, counted from the moment of fertilization was 8 times 24 hours old, and in which when perfectly at rest I counted 144 pulsations to the minute, yielded the following result:

Moment of Time	Consecutive number of the heart-beat synchronizing with the moment of time marked in the first column.	Number of pulsations in 10 seconds.	Number of pulsations per minute. (When perfectly quiet 144.)
0 Seconds	heart arrested by moving egg to and fro with two needles.		
		3	18
10 Seconds	3		
		20	120
20 Seconds	23		
		21	126
30 Seconds	44		
		24	144
40 Seconds	68		
		24	144
50 Seconds	92		

After arresting the heart by moving the egg to and fro with two needles, the egg in the last table and a few other kepala timah eggs artificially fertilized and 8 times 24 hours old, usually showed the first heart-beat again after 2 to 4 seconds.

It afterwards became clear to me that the first-discussed egg, found in a tuft of *Chaetomorpha* taken from an empang, and in which disturbances acted so powerfully on the number of heart-pulsations, was not a normal one. When I made the experiments afore mentioned with this egg,

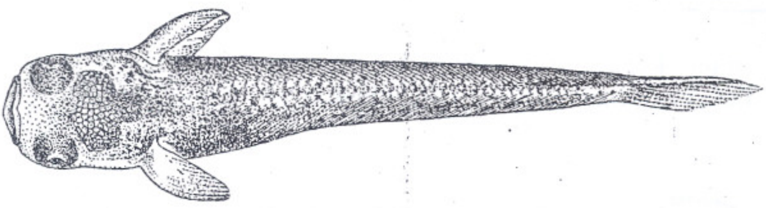

Fig. 31. A young kepala timah (*Haplochilus panchax* (HAM. BUCH.)) just out of the egg-capsule, seen from the dorsal side. $\times$ 20 $^1/_2$.

it was from a comparison with artificially fertilized eggs, older, and considerably older than 8 days, from the moment of fertilization. This embryo was then far less active and energetic than other embryos 8 or more than 8 times 24 hours old. Furthermore 6 times 24 hours later, i.e. when it was considerably more than 14 times 24 hours old it had not yet disclosed, and 24 hours later again I ascertained that the embryo had died inside the egg-capsule.

Eventually it appeared to me that the number of heart-beats to the minute may vary considerably even in embryos of the same age. Thus the number of pulsations per minute of 3 embryos, 8 times 24 hours old, from artificially fertilized eggs of *Haplochilus panchax*, was 145, 148 and 164 to 167.

This latter remark also holds for *Haplochilus javanicus* for which I found the following numbers of heart-beats in embryos a little over 6 times 24 hours old.

Eggs of *Haplochilus javanicus* (BLKR.). Embryos a little over 6 times 24 hours old	Number of heart-beats per minute
a	148 — 150
b	153
c	168
d	173 — 175
e	188 — 189

A considerable time after I had completed this Chapter VI, as far as it is found above, SYBRANDI's (37) paper in De Tropische Natuur, Part II, page 133 ff., came to my notice and I found that among other things it also dealt with *Haplochilus panchax* (HAM. BUCH.).

For *Haplochilus panchax* (HAM. BUCH.) SYBRANDI (37) mentions, besides the Malay name of "kepala timah", also the Sundanese appellation of "sisik malik" and the Javanese "pitak", but he does not give the name "wader tjéto", which, as I have mentioned, would be the name given to our kepala timah in Central Java, according to GRONEMAN (24).

SYBRANDI (37) too has observed that the eggs of *Haplochilus panchax* (HAM. BUCH.) are attached to water plants. He writes: "The female attaches the fairly large eggs to aquatic plants by means of **a** viscid **thread** these eggs possess". Now it is apparent from my figures 20 and 21 (and from my figures 22—30 after eggs of *Haplochilus javanicus* (BLKR.)), that especially when the eggs get a little older, several adhesive threads twisted into a string, may to the naked eye make the impression of a single (bigger) thread; for which compare also my remarks on fig. 21 above.

SYBRANDI (37) says that the development (within the egg-capsule) of the kepala timah takes about 7 days. As I stated above, at my laboratory, under the conditions described by me, 8 out of 12 artificially fertilized kepala timah eggs came out after more than 8 and less than 9 times 24 hours after fertilization.

What SYBRANDI (37) says concerning the food of the kepala timah tallies exactly with what I communicated about it in the foregoing. SYBRANDI (37) writes as follows: "They" (scil. the kepala timah) "are extremely voracious and feed on live prey only. Small worms, young fry and mosquito-larvae are their favourite nutriment......"

SYBRANDI (37) also thinks he has observed that "the appearance" (of the little white spot on the head of the kepala timah) "is not attributable to the intensity of the light alone".

Further SYBRANDI (37) mentions the power of the amorous male of varying its colours at discretion within certain limits. This is to be accounted for from the well-known fact that the melanin- and lipochrome-chromatophores discussed above, are able to expand their pigment containing cell-body in an amoeboid manner and inversely to contract it into a minute ball. SYBRANDI (37) describes the colour of the kepala timah as greyish (or sallow-grey, "vaal grijs") under normal circumstances. Judging from my *Haplochilus panchax* (HAM. BUCH.) originating from the Batavia empangs, the description as "greyish" does not seem to me very fortunate in this instance. But I think it is sufficient for me to refer to my observations and remarks higher up on the colours of the kepala timah, originating from the Batavia empangs.

SYBRANDI (37) further says that the anal fin in the female kepala timah is "shorter" than in the male. This question resolves itself into the following facts:

In both the male and the female the anal fin has the same number (usually 17) of fin-rays. On the whole however the fin rays are far more branched in the male than in the female, especially in the caudal half of the anal fin. Moreover in the female it is the 7th, 8th and 9th rays of the anal fin that are longest, whilst in the males the successive rays increase in size up to the 14th or 15th ray. In accordance with this in the female the postero-distal end of the anal fin is rounded off, whilst the same extremity in the male grows to a point.

CHAPTER VII.

The Anopheline larvae of the Batavia empangs.

The data dealt with in this chapter were collected in 1918 and 1919, partly by the then Chief of the Public Health Service (Chef van den Gezondheidsdienst) at Batavia, Mr. M. L. VAN BREEMEN, partly by myself.

Mr. VAN BREEMEN and his staff determined and counted the female [1]) Anophelines caught with mosquito-nets and hatched out of larvae and pupae collected. In the places where the mosquito-nets had been set and/or the larvae and pupae had been caught, care was taken each time to also

[1]) In the case of Anophelines it is often easier to determine the females than the males, because for the distinction of the species it is often convenient to go by the characteristics of the female palpi.

PL. XXII.

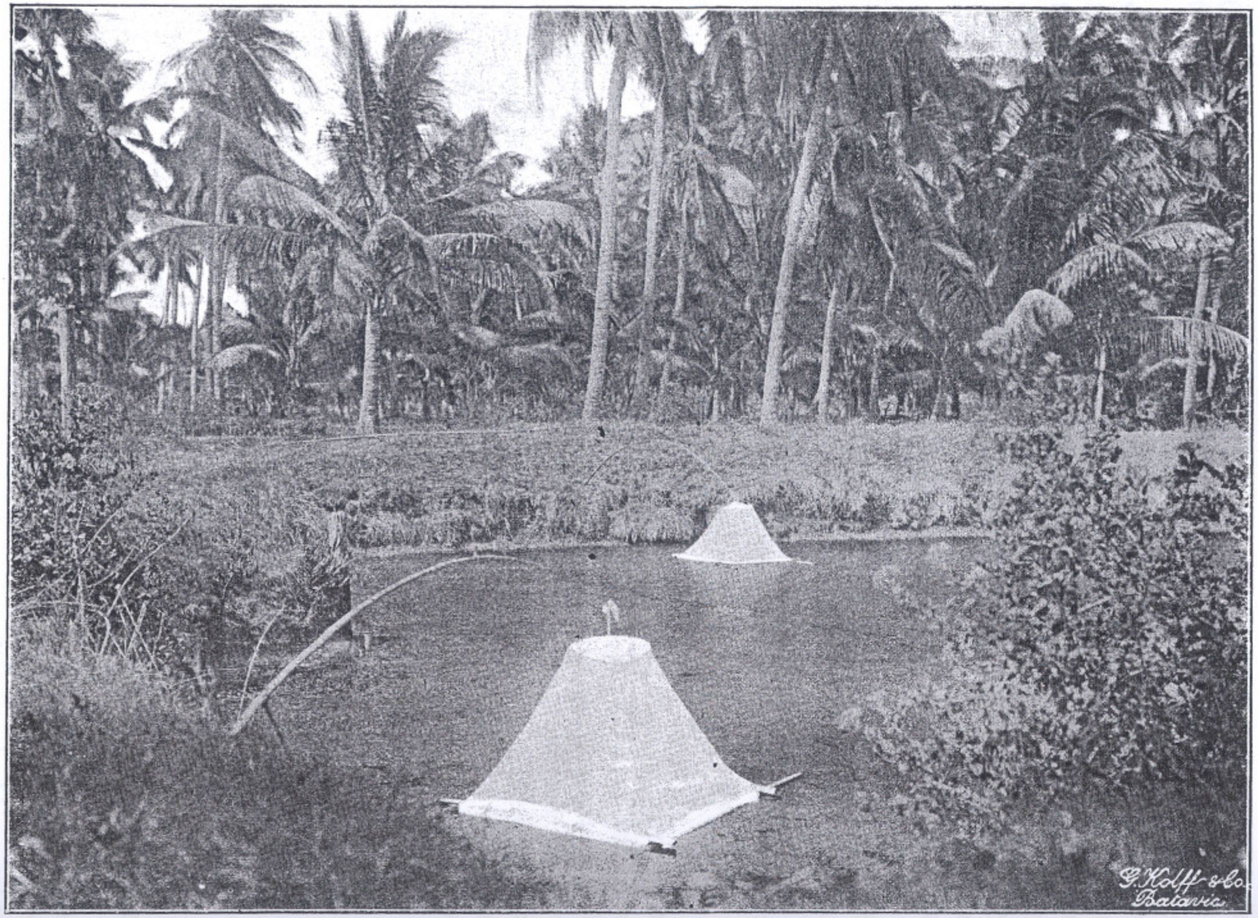

Photo no. 14. Floating mosquito-nets of Mr. VAN BREEMEN's devising enclosing exactly 1 M^2 of the water-surface. The nets are set, in a little marine fish-pond on the Groningsche weg, on the submerged vegetation reaching up to just beneath the surface of the water and consisting mainly of *Chaetomorpha* (cf. Chapter IV).

collect a water-sample and frequently also a sample of the submerged vegetation. The composition of the samples of the submerged vegetation was examined by me and I also determined the salinity of the water-samples. In this manner Mr. VAN BREEMEN and I collected 490 sets of combined data, laid down in the observation-table (Table IV). The salinity of the water was determined in 489 cases, one water-sample being lost before it had been examined. Analyses of samples of the submerged vegetation gathered in the observation-places were made in 226 cases.

As regards the figures given for the Anophelines, when in March 1918 Mr. VAN BREEMEN and I started the regular collection of data at the Batavia empangs, Anopheline-larvae and -pupae were being caught in the marine fish ponds by the Public Health Service, in the manner indicated by SCHÜFFNER and SWELLENGREBEL (51) (page 55), i. e. by means of white enamelled plates, white enamelled rice spoons and empty quinine bottles. As it is impossible to distinguish from each other the larvae of the two species of Anophelines produced by the Batavia empangs, viz. of the dangerous malaria transmitter *Myzomyia ludlowi* THEOBALD and of *Myzomyia rossii* GILES, salt-water type (cf. a.o. MANGKUWINOTO (54) and SWELLENGREBEL (57) (58)), the only thing to do then was to determine the imagines which afterwards developed from the larvae and pupae collected [1]).

From the beginning it seemed to me that it would be very difficult to obtain by this method adequate, and by adequate should be understood here comparable quantitative data concerning the production of different species of Anophelines by various breeding-places. I therefore proposed to Mr. VAN BREEMEN to proceed to catches by mosquito-nets, which would yield data relative to the production of Anophelines per unit of surface-area of the breeding-place and per night. I subsequently learned that also Sir RONALD ROSS (32) as early as 1908 had made use of mosquito-nets, in order to study the production of Anophelines of "Clairfond Marsh", Mauritius.

ROSS discusses these catches with mosquito-nets in his well-known work "The prevention of malaria" (32) (cf. pages 165 and 166 and the upper illustration facing page 166). On that occasion he points out how great is the need of adequate quantitative data of this nature, collected by means of mosquito-nets.

Mr. VAN BREEMEN accordingly had mosquito-nets made of a model of his own devising. These mosquito-nets are to be seen in our photos 14 and 15 (Plates XXII and XXIII). At the bottom they are held open by a square frame composed of four bamboos, which floats and encloses exactly 1 M^2 of the water surface. At the top the mosquito-gauze is

[1]) Pupae of Anophelines are not described either by MANGKUWINOTO (54), or by SWELLENGREBEL (45) (57) (58), or by SCHÜFFNER and VAN DER HEYDEN (46). In this connection the question arises as to whether the pupae of *Myzomyia ludlowi* THEOBALD and *Myzomyia rossii* GILES, salt-water type of MANGKUWINOTO (54) are distinguishable from each other.

fastened round a hoop of rattan, the space inside the hoop being closed by a circular piece of cotton. In the centre of this cotton top-piece there is at the outside a loop to which is fastened one extremity of a long elastic piece of split bamboo. The other end of this piece of split bamboo is fixed in the ground in such a manner that the bamboo, which is slightly bent and therefore resilient, keeps the mosquito-gauze stretched. These mosquito-nets present the advantage that they do not drift away, being kept in the exact spot where they are fixed, and yet are able to follow vertical movements of the water surface which may occur in connection with the admission or draining away of pond-water. There is also a second advantage. The bamboos forming the lower frame can be withdrawn one by one from the hem at the bottom of the gauze, after which the net can be closed and tied under water. When the loop at the top of the net is detached from the long piece of split bamboo, the mosquito-gauze kept open by the rattan hoop, with all the mosquitos caught, forms an exceedingly light burden. Fixing them by the top-loop to a long stick or bamboo a coolie can then with the greatest ease carry ten or more of these nets with the mosquitos caught, from the spot where they are caught to the place, a long distance off in our case, where the captured mosquitos must be determined and counted.

It was the practice to set several of these nets at the same time in the same breeding-place, for which the staff of the Public Health Service were employed. In this connection a breeding-place should be understood as meaning a fish-pond, or speaking more accurately, as will appear from what follows, that part of a fish-pond where the submerged vegetation described in Chapter IV and represented in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII), has developed. As may be seen from the observation-table (Table IV), it was usual to set 7 to 10 or at least 5 nets together in one and the same breeding-place. Occasionally we had to be content with fewer than 5 nets per breeding-place; this however occurred only in January and February 1919. The nets were set in the afternoon and taken in the next morning. The corresponding samples of water and submerged vegetation were gathered in the morning when the nets were taken in. The number of times a set of nets was put out in the Batavia marine fish-ponds was 399.

Besides this Anopheline larvae and pupae were collected from the Batavia empangs 247 times by coolies under the direction of the staff of the Public Health Service, mostly from the same breeding-places in which a set of mosquito-nets had also been placed. I have already related above that it was then only possible to determine and count the imagines (♀♀) that developed from the larvae and pupae collected.

In SCHÜFFNER and SWELLENGREBEL's Guide for the epidemiological malaria-research (Handleiding voor het epidemiologisch malaria-onderzoek) ([51]), it is rightly remarked on page 53 that when studying an Anopheline

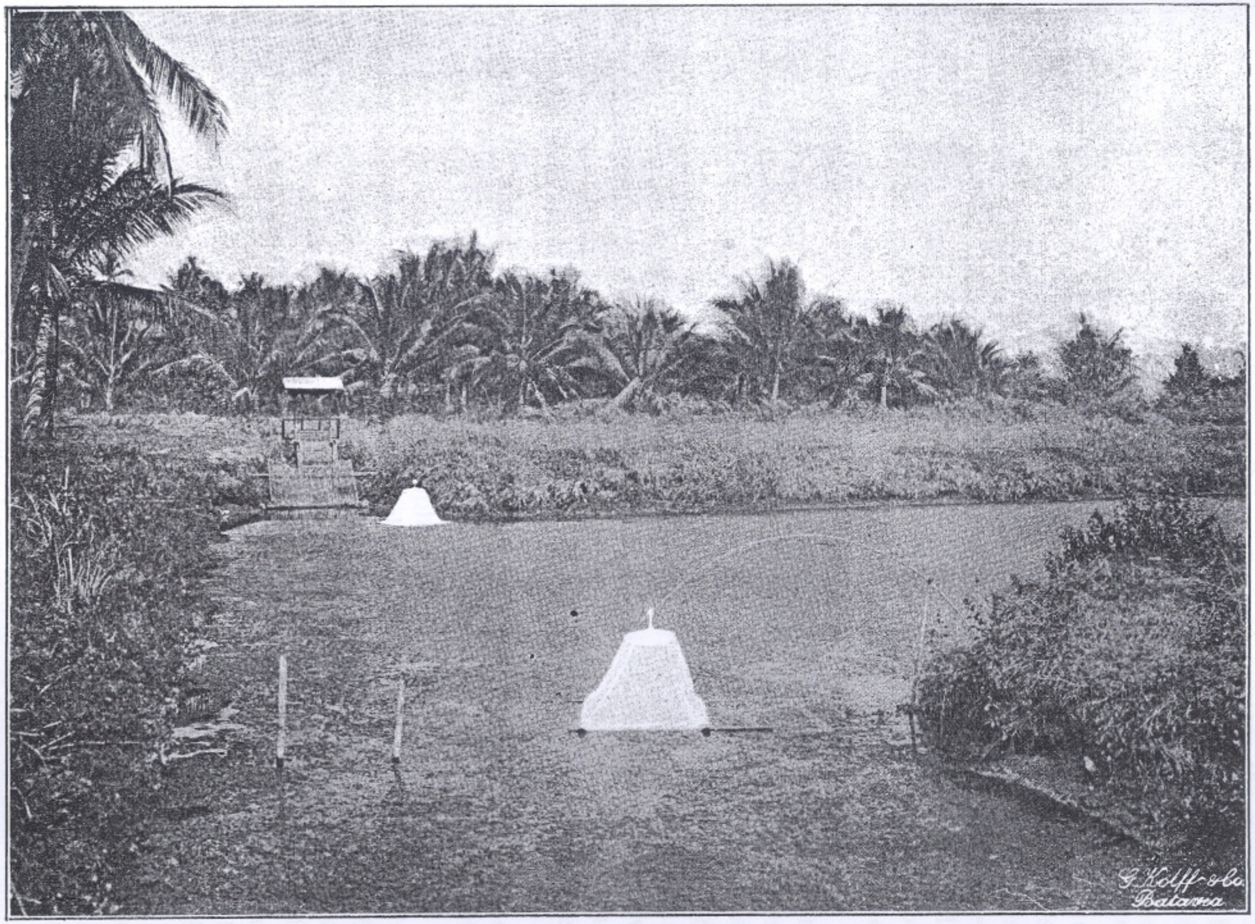

Photo no. 15. Floating mosquito-nets of Mr. VAN BREEMEN's devising enclosing exactly 1 M^2 of the water-surface. The nets are set, in a marine fish-pond on the Groningsche weg, on the submerged vegetation, reaching up to just beneath the surface of the water and consisting mainly of *Chaetomorpha* (cf. Chapter IV).

breeding-place "it is necessary not only to carry out the investigation qualitatively, but to do so quantitatively as well". Now to work quantitatively it is necessary to adopt a unit in which to express the wealth in Anopheline larvae (and pupae) of a given breeding-place. The unit with which SCHÜFFNER and SWELLENGREBEL (51) wish to work is a catch-unit. It is their notion to determine the number of Anopheline larvae (and pupae), captured in a breeding-place by the method indicated by them (51) on page 53, getting the larvae (and pupae) caught for a definite time and equally over an area of a definite size, by a definite number of catchers, if possible always by the same men, by means of white enamelled plates, white enamelled rice-spoons and empty quinine bottles. It is however evident that this quantitative method can hardly be carried out efficiently unless by trained catchers and under the strict and constant supervision of some person who is perfectly aware of the meaning and the object of the process. [1])

But even when such supervision is possible and the catchers are well-trained, it still remains a question with me in how far the numbers of Anopheline-larvae and pupae, captured after this method in let us say a pond in which the larvae-catching coolies are obliged to wade through the water and the muddy pond-bottom and on a field on which there are footprints of buffaloes filled with water, can afford a basis for comparative study. Indeed SCHÜFFNER and SWELLENGREBEL (51) themselves say that the quantitative method proposed by them "is a very rough one and neces- "sitates a wide margin for errors".

Only one attempt at applying this quantitative method is mentioned in the Netherlands East Indian malaria-literature [1]). In their article "On the "conditions required by different Anophelines for the dwelling-places of "their larvae" (Over de eischen die verschillende Anophelinen stellen aan de woonplaatsen hunner larven) [2]), SWELLENGREBEL and Mrs. SWELLENGREBEL-DE GRAAF (58) say: "The method we applied to obtain however "imperfect a quantitative, and not a merely qualitative insight into the "numbers of Anopheline larvae of each species to be captured, has already "been communicated by us before (SCHÜFFNER and SWELLENGREBEL, "Guide for the Epidemiological Malaria-research (Handleiding voor het "Epidemiologisch Malaria-onderzoek), Weltevreden 1918)".

However, further on in the article referred to (58) no attempt is made anywhere to express the catches of larvae in the quantitative catch-unit expounded by SCHÜFFNER and SWELLENGREBEL (51). On the contrary,

[1]) After this chapter had been written I saw in Sumatra (Penjabungan, Tapanuli) how the exceedingly well-trained native staff of Prof. Dr. W. A. P. SCHÜFFNER, in whose company I had the privilege to travel, were able to collect adequate quantitative data by the method in question.

[2]) Of this article as of other publications of the Netherlands East Indian Civil Medical Service, not only the original Dutch text but also an English translation has been published. I however prefer to use our own English translation of the passages from SWELLENGREBEL's (58) original Dutch text quoted here.

SWELLENGREBEL himself declares in an appendix to his article ([58]), entitled: "Note to the tables and the graph": "The number of larvae captured in "each category of finding places, should not be taken as a standard of the "prevalence of larvae in that category, for in some of those categories, "especially the inland fish-ponds, the catching has been carried out longer "and more intensively than for instance in the salt-water fish-ponds on "the coast, so that it might seem that in the former there occur more "larvae and especially more *ludlowi*-larvae than in the latter, whereas in "reality it is just the other way about. Furthermore one might, for "the same reason, think that large lakes (Lake Manindjau) are unim-"portant for the *ludlowi*-production; but there are there, relatively, far more "*ludlowi* than in the fish-ponds; however only one catch was made there, "against daily catches continued for months in the fish-ponds". In view of this statement I am surprised that SWELLENGREBEL ([58]) should have published his Table IIIa, "stating the percentage of the total number of "larvae of each species captured in each category of breeding-places", and the accompanying Graph representing the "distribution in percentages of the larvae of each species captured, over the eleven categories of finding places". The table and graph referred to show nothing concerning the relative productivity of the different categories of breeding-places in larvae of different species of Anophelines, indeed they may convey an erroneous impression thereanent. For a reader who does not go through the article carefully and critically from A to Z but, who in the first place looks at the tables and such things, as may be expected to happen frequently, will in most cases, it seems to me, at least begin by thinking that the intention of Table III a and the accompanying Graph must be to give a survey of this relative productivity. Whilst SWELLENGREBEL himself says ([58]) (page 58) that relatively the large lakes (Lake Manindjau) produce far more *ludlowi* than the fresh-water fish-ponds, his Table III a gives for "*ludlowi*, interior": 98 % for the category of breeding-places "fresh-water fish-ponds" and 1,8 % for the category "large lakes"!

In the same way it seems to me highly improbable that the values given for "*ludlowi*-coast" in Table III a and in the corresponding Graph of SWELLENGREBEL for the categories of breeding-places "salt-water fish-ponds", "salt water outside the fish-ponds" and "fresh water near coast", which are in the same order 66 %, 21 % and 12 %, should even approximately tally with the figures rendering the real relative productivity in *ludlowi* of the said breeding-places. Now I know very well that SWELLENGREBEL does not claim that his table and graph should express that relative productivity, but it is hard to see what purpose is served by the publication of his table and graph, unless they did express this relative productivity.

In the case of the investigation by Mr. VAN BREEMEN and myself the catches with mosquito-nets yielded fully reliable and thoroughly comparable data concerning the magnitude of the production of Anophelines by the Batavia empangs per unit of surface-area and per night.

As I had occasion to mention before, our mosquito-nets were always set in those places in the Batavia empangs where the submerged vegetation described in Chapter IV and illustrated in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII, and XXIII) had developed more or less luxuriantly. With a single exception therefore, to which I will refer again later on, the nets were not set on open pond-water.

As a matter of fact the open water of the Batavia empangs is practically free from Anopheline larvae. As early as 1908 KIEWIET DE JONGE (26) wrote: "thus the larvae" (sc. Anopheline larvae) "are found there" (sc. in the Batavia empangs) "especially in and among the numerous conglomerates "of water-plants floating there". VAN BREEMEN (59) also says that in 1917 and 1918 he learned from observation that in the empangs "the Anopheline "larvae chiefly lurked in the algae floating at the surface of the water and "in the vegetation of higher aquatic plants growing up to the surface, "which water plants enable the larvae to hold their own in the struggle "with the larvae- and pupae-devouring fishes". Further down in the same article VAN BREEMEN (59) says once more that "in normal circumstances "the open water is free from mosquito-larvae owing to the presence of "kepala timah" (= *Haplochilus panchax* (HAM. BUCH.), cf. Chapter VI).

It is a recognised fact that here in the tropics it is generally speaking open water alone that can be kept practically free from mosquito-larvae and -pupae by the presence of a sufficient number of fish preying on those larvae and pupae. Thus the following passage is met with in the well-known "Handbuch der Tropenkrankheiten" by MENSE (50) (Volume V, p. 439) in the Chapter on malaria prophylaxis, where the "Feinde der Mückenlarven aus Pflanzen- und Tierreich" are discussed: "Fische scheinen für manche Gewässer eine ziemliche Bedeutung zu gewinnen, aber nur wenn sich kein starker Pflanzenwuchs darin befindet und die Ufer steil ansteigen, da anderenfalls die larven zu viel Schutz finden". (This passage has already been quoted on page 235).

WILSON (47) also says: "When introducing fish into ponds for purposes "of destroying mosquito larvae, it is necessary to conserve such waters by "the removal of surface weeds and floating débris near the margins and "draining or filling in isolated pools near the foreshore. The value of "this conservancy became apparent to me during my earliest experiments "with fish as larvicides. The ponds which were selected for the first "experiments were comparatively clear of surface weeds and floating débris "and mosquito larvae could be found near the margin. They were stocked "with larvae-eating fish and after a few days were thoroughly examined, "with the result that no larvae could be traced excepting above some "patches of surface weed; this weed was promptly removed and a further "search was made the following day with a negative result.

"The margins of ponds, etc. should be trimmed and over-hanging "plants that reach to the surface of the water should be cut back, as these "tend to hold up débris and protect the larvae. All small isolated puddles "should be filled in or drained".

In Chapter VI when discussing the food of the kepala timah (*Haplochilus panchax* (HAM. BUCH.)), I pointed out that MENSE (50), WILSON (47) and SEYMOUR SEWELL and CHAUDHURI (35) count certain species of *Haplochilus,* among which *Haplochilus panchax* (HAM. BUCH.), among the best destroyers of mosquito-larvae and pupae, and that it even became apparent to SEYMOUR SEWELL and CHAUDHURI (35) from comparative experiments that these species of *Haplochilus* are still far better larvicides than the famous millions (*Girardinus poeciloides* DE FILIPPI) of Barbados.

Nevertheless, as I already stated in Chapter VI, in spite of the continuous presence of very great numbers of *Haplochilus panchax* (HAM. BUCH.) there, the Batavia empangs teem with larvae and pupae of *Myzomyia ludlowi* THEOBALD and *Myzomyia rossii* GILES, in those places where masses of algae float at the water-surface, or more generally, where the submerged vegetation reaches the surface of the water and sometimes also where the over-hanging land-plants touch the surface of the water or even (*Paspalum distichum* L.; cf. Chapter I) extend their growth along the pond-bottom when the latter is covered by very little water only.

The chief factor seems to be that the submerged algae and higher water-plants floating at or reaching up to the surface of the water together with the over-hanging land-vegetation of the pond-margin touching the water-surface, protect the eggs, larvae and pupae of the mosquitos more or less from the animals preying on those eggs, larvae and pupae, these animals being in the first place *Haplochilus panchax* (HAM. BUCH.). Most authorities are agreed as to the correctness of this view, as may appear from the above-quoted sentence from MENSE (50). WILSON (47) also states that "surface weeds etc. protect the larvae from their enemies".

Further HILDEBRAND (53) writes: "Algae often form mats which float "at or near the surface. Mosquito larvae, particularly Anopheles, find protection "from fish over and in these mats. . . . .
. . "The aquatic plant, *Najas flexilis,* which was common in several "ponds, forming a dense growth over the bottom, normally does not provide "protection, as it does not reach the surface of the water. During the severe "fall drought the water, hoewever, became so low that it was near the "surface or partly exposed in many places, making such a dense mass that "fish could not penetrate it. Wherever this occurred it furnished excellent "protection and *Anopheles* larvae and pupae were common. . . . . .
. . "Nearly all marginal plants, by projecting partly into the water, by falling into it after maturing, or by becoming partly submerged after freshets, furnish protection for mosquito larvae. . . . .

. . . "It is evident from the study of plants in relation to mosquito control "by means of fish that it is highly desirable to remove from the ponds "those plants having leaves just below the surface of the water and to treat "algae in such a way as to make them useless as protectors of mosqitoes. "The presence of these plants was by far the most important obstacle to "be overcome in securing mosquito control in the many ponds in the "extra-cantonment zone of Camp Hancock".

It can be easily observed in the Batavia empangs that the Anopheline larvae are largely protected from the *Haplochilus panchax* (HAM. BUCH.) that devour them, by the dense conglomerates of water-plants, consisting in the first place of *Chaetomorpha* (cf. Chapter IV), that are represented in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII). *Haplochilus panchax* does not penetrate into those thick algal [1]) masses, at least not far. On the other hand these masses of algae [1]), as shown by our catches with mosquito-nets, may produce great quantities of Anophelines whose larvae can a.o. be found in the filmy layer of water covering the algal [1]) masses and in small openings or depressions in the upper surface of these conglomerates of water-plants, in which places the larvae are practically speaking perfectly safe from the *Haplochilus panchax*.

Accepting accordingly that in the Batavia empangs the Anopheline larvae and pupae are certainly well protected from the voracity of *Haplochilus panchax* (HAM. BUCH.) in those places where a more or less dense submerged vegetation, reaching the surface of the water, has developed, which is not the case in open water, I am perfectly willing to admit the possibility of the view that perhaps the conditions of life amid the submerged vegetation are yet in other respects more favourable to the Anopheline larvae (and pupae) than in open water. One might for instance think with SWELLENGREBEL (62) of the food of the Anopheline larvae.

SWELLENGREBEL (62) does not express any views as to the nature of this food. The intestine contents of some larvae of *Myzomyia rossii* GILES and/or *Myzomyia ludlowi* THEOBALD I found to consist of various fine vegetable and animal detritus, among which e.g. very small fragments of Enteromorpha, and of minute Diatoms.

The facts are therefore briefly as follows: In those places in the Batavia empangs where the frequently mentioned submerged vegetation floating at or reaching up to just beneath the surface of the water occurs and, to a lesser degree, also where the overhanging marginal vegetation projects partly into the water, the conditions of life for the larvae (and pupae) of *Myzomyia rossii* GILES and *Myzomyia ludlowi* THEOBALD are so favourable, principally because of the mechanical protection against *Haplochilus panchax* (HAM. BUCH.), as to render possible the production of myriads of these Anophelines,

[1]) cf. note page 209.

in spite of the presence of swarms of the said larvae- and pupae-eradicating fish.

On the contrary the conditions of life for the larvae of both species of Anophelines in the open water of the Batavia empangs are so unfavourable that, provided *Haplochilus panchax* (HAM. BUCH.) be present in sufficient numbers, this open water is practically free from Anopheline larvae [1]). The right of writing down the above words printed in spaced type I derive from the fact that by far the greatest production of Anophelines that Mr. VAN BREEMEN and I could observe in the Batavia empangs occurred as a matter of fact in ponds with entirely open water, absolutely clear of algal masses or other macroscopically visible water-plants and without any overhanging vegetation on the margins but from which *Haplochilus panchax* (HAM. BUCH.) happened to be entirely absent.

The ponds in question are situated near Heemraad Oost. On October 22nd 1918 these ponds were still quite dry. They had then been dry already for some considerable time, so that all the aquatic plants and animals had perished or disappeared and the bottom of the pond had cracked in many places. On November 13th following Mr. VAN BREEMEN saw that these ponds contained water again. Both kepala timah and algal masses or higher water plants were entirely missing, yet the ponds were absolutely teeming with mosquito larvae.

On November 18th I also visited these ponds and I could personally ascertain the facts, that the ponds contained no algal masses or higher aquatic plants and no *Haplochilus panchax* (HAM. BUCH.), but were still swarming with huge numbers of mosquito larvae and pupae, which, together with many empty pupa-skins had been driven together by the wind so as to form a dense strip along the lea-edge of the ponds.

The salinity in these ponds was in three different places 35.3; 40.7 and 25.0 $^0/_{00}$. On the spot where the salinity was 25.0 $^0/_{00}$ and where great masses of larvae, pupae and empty pupa-skins had been driven together in a corner of the pond by the wind, four mosquito-nets were set on November 14th, 1918. Next morning the contents of these four nets were examined by Mr. VAN BREEMEN and his staff. 999 Female Anophelines were then determined. Five of these were *Myzomyia ludlowi* THEOBALD, the remaining 994 being *Myzomyia rosii* GILES. The whole contents of the nets may be tabulated thus:

[1]) In this connection the following fact also seems to me significant. In empangs containing floating algal masses and higher submerged plants reaching up to just beneath the surface of the water, the mosquito larvae and pupae in the open water that have not been gobbled up by *Haplochilus panchax* (HAM. BUCH.) are continually driven together by the wind into the protecting milieu of those conglomerates of aquatic plants and of the marginal plants projecting partly into the water. Moreover the larvae concentrate actively into places of protection like surmerged aquatic plants reaching the water surface, overhanging land plants projecting partly into the water, floating débris etc.. The latter fact has already been observed by HILDEBRAND ([53]).

Mosquito-nets	*Myzomyia rossii* GILES and *Myzomyia ludlowi* THEOBALD ♂♂	*Myzomyia rossii* GILES 99½% and *Myzomyia ludlowi* THEOBALD ½% ♀♀	Other Culicidae
1	1820	2461	4763
2	256	315	655
3	744	861	1862
4	2479	3313	6050
Total . . .	5299	6950	13330

Total general . . . . 25579 mosquitos.

The open pond water therefore in this case produced 25.579 mosquitos per 40.000 cM^2, that is about 1 mosquito for each 1½ cM^2. In the case of net no. 4 the production in one night even amounted to 11.842 mosquitos per M^2, that is more than 1 mosquito per cM^2.

Consequently, as against the very slight production of mosquitos in open empang-water when the normal, large number of k e p a l a t i m a h are present, we have here an enormous production of mosquitos in open empang water whence *Haplochilus panchax* (HAM. BUCH.) were completely absent.

Considering the fact that from the 13th to the 18th of November 1918 the mosquito-larvae and pupae continued closely packed together all the time in the same strip of water along the southern margin of the long and narrow ponds stretching east and west, and that consequently they fed, grew and finally emerged in that same space, it still seems to me a moot point, whether we ought to look upon the production found as the production of the entire pond wherein the mosquito-nets had been set or as the production of the southern strip alone of that pond which was occupied by the mosquito-larvae and -pupae.

Also in the ponds with submerged vegetation, reaching the surface of the water and with overhanging marginal land-plants apart from the eradication wrought among the mosquito larvae and pupae in the open water by the kepala timah, these larvae and pupae are not only continually driven together by the wind but also concentrate actively away from the open water into the shelter offered by the conglomerates of algae and higher submerged aquatic plants reaching up to just beneath the surface of the water and by the overhanging land-vegetation along the pond margins [1]). But even if we take the mosquitos produced by the southern strip of the pond without any macroscopically visible vegetation and from which kepala timah

[1]) cf. note page 262.

were entirely absent as the production of the entire pond, that production is still enormous.

This becomes apparent on a comparison of the quantity of *rossii* ♀♀ produced in the present case by the open empang-water, with the largest catches among the 398 made by us above the submerged vegetation, also of *rossii* ♀♀.

In Tables V and VI the reader finds the quantitative results of all the catches by mosquito nets expressed in the numbers of *ludlowi* and *rossii* ♀♀ captured per night and per 10 M^2. In the case discussed above the open pond-water produced per 10 M^2 and per night $\frac{10}{4} \cdot \frac{99^1/_2 \times 6950}{100} = 17288$ *rossii* ♀♀. Now taking the view that the mosquito-larvae and pupae had been driven together by the wind within $^1/_{10}$ of the pond-area and therefore dividing the catch by 10, even then this catch of *rossii* ♀♀ made over open pond-water in a pond destitute of kepala timah remains considerably higher than the biggest catch of the same mosquitos, out of 398 catches made above the submerged vegetation in ponds in which *Haplochilus panchax* (HAM. BUCH.) did occur. This biggest catch referred to amounted to 1466 *rossii* ♀♀ per 10 M^2 and per night (cf. the Tables IV, V and VI; November 24th 1918, Jaagpad). As regards the *ludlowi* ♀♀, the biggest of 398 catches amounted to 648 ♀♀ per 10 M^2 and per night (cf. Tables IV, V and VI, July 25th 1919, Heemraad) [1]).

Our observations discussed here concerning the ponds near Heemraad Oost are not isolated cases. Already on October 15th 1918 Mr. VAN BREEMEN had discovered near Pekulitan a little bandeng fry pond containing no kepala timah and practically no water-plants. The fact is that from a bandeng fry pond the rearers remove not only all kepala timah, which would devour the bandeng fry, but frequently also the water-plants or at least the bigger algal masses, as the young fry gets entangled in dense algal masses such as are formed especially by *Chaetomorpha*. The open water of this little fry pond perceived by Mr. VAN BREEMEN near Pekulitan, in which kepala timah therefore was not present, as a matter of fact swarmed with larvae and pupae of Anophelines and other Culicidae. Similar huge masses of mosquito-larvae and -pupae were observed by us only in the ponds of Heemraad Oost just discussed and likewise destitute of kepala timah, but never in ordinary empangs containing the normally very great numbers of kepala timah.

Now it will not do to conclude that it is only in consequence of the absence of kepala timah in the cases here described that the enormous

[1]) It is self-evident that the fact of the enormous numbers of Anophelines produced in the above case by the open pond-water consisting, at least as regards the females, for $99^1/_2$% of *Myzomyia rossii* GILES and only for $^1/_2$% of *Myzomyia ludlowi* THEOBALD, has no bearing on the significance of this case for judging of *Haplochilus panchax* (HAM. BUCH.) as an eradicator of mosquito-larvae and -pupae. Either the natural conditions in the ponds in question were more favourable to the larvae of *rossii* than to those of *ludlowi*, which as we shall see below is quite possible, or far more *rossii* than *ludlowi* ♀♀ laid their eggs in the ponds in question after these had been replenished.

production of mosquitos was brought about. From the nature of the case a definite conjuncture of favourable conditions is required to render such an enormous production of mosquitos possible. But one of those conditions, indispensable to the appearance of such an enormous production of mosquitos, is the absence of the great numbers of kepala timah normally to be found in empangs; in other words the enormous production of mosquitos would not have taken place if the normally great number of kepala timah had been there.

In my opinion the following words of WILSON (47) are entirely applicable to the Batavia empangs and to the part played in them by *Haplochilus panchax* (HAM. BUCH.): "That they" (scil. fish eradicating mosquito larvae and pupae) "play an important part in keeping down fly pests, such as "mosquitos, etc. is an undoubted fact, and if it were not for their presence, "we would have millions of mosquitos where we have hundreds now".

Now once more summarizing my views on *Haplochilus panchax* (HAM. BUCH.) as an eradicator of mosquito larvae and pupae in the Batavia empangs, and referring the reader also to Chapter VI, I then start from the following facts:

a. that the kepala timah, kept for a long time at my laboratory in various small aquaria which were in biological equilibrium and in which had been collected algae and higher submerged aquatic plants together with smaller animals such as Gammaridea, Copepods, Gladocera, Ostracods, Hydroporines etc. etc. from the Batavia empangs, regularly devoured with great avidity large quantities of Anopheline larvae and pupae;

b. that in the alimentary canal of more than a hundred kepala timah whose intestine-contents I examined immediately after they had been caught in the empangs, I found, besides remains of various other smaller and occasionally somewhat larger (Nereidae) animals living in the empangs, invariably also larvae and pupae of Anophelines or remains of those;

c. that Mr. VAN BREEMEN and I in the course of 18 months' investigation of the empangs, ascertained twice — and that in open empang-water — a production of mosquitos far in excess of the usual Anopheline production of the empangs, determined by us quantitatively in 398 cases; and that this enormous and abnormally high production of mosquitos both in the ponds of Heemraad Oost and in the little fry-pond near Pekulitan coincided each time with the total absence of *Haplochilus panchax* (HAM. BUCH.) which otherwise is regularly met with in large numbers in the Batavia empangs.

From these facts I think I am warranted in concluding that there is more danger of the larvae and pupae eradicating action of *Haplochilus panchax* (HAM. BUCH.) being underrated than over-rated, and that the production of mosquitos by the Batavia empangs is kept down in a considerable measure by the large numbers of kepala timah which are nearly always present there. I have consequently arrived at very much the same conclusion as for instance WILSON (47) and SEYMOUR SEWELL and CHAUDHURI (35), from both of which authors I have already quoted in Chapter VI a few passages bearing upon the problem under discussion.

On the other hand we have already seen before that, even where large numbers of kepala timah are present, the mosquito production in the empangs containing floating algal masses or higher submerged plants reaching up to just beneath the surface of the water is by no means reduced to nil. All sorts of factors finally contribute to prevent the consumption of all the larvae and pupae present in the ponds by these little fish, however eager they may be in devouring larvae and pupae. Something similar will also be often the case in other breeding-places than the empangs. Hence it may be but very rarely expected that the introduction of animals preying on mosquito larvae and pupae in a natural breeding place of mosquitos should prove an absolutely effective means of combating the mosquito-pest or the malaria-peril.

I have gone into this question of the importance of *Haplochilus panchax* (HAM. BUCH.) as an eradicator of mosquito larvae and pupae in some detail, because SWELLENGREBEL (62) recently thought himself obliged, on the strength of some experiments and a few observations, to arrive at conclusions which do not agree with my views as stated here.

In the article in question by SWELLENGREBEL (62) three little fish are discussed as destroyers of mosquito-larvae and pupae, viz. *Haplochilus panchax* (HAM. BUCH.), *Ophiocephalus striatus* BL., and *Dangila cuvieri* C. V..

Concerning *Haplochilus panchax* (HAM. BUCH.) it resulted from a simple experiment, for the purpose of which once 3 and twice 2 individuals were kept in 10 L. glasses, that as SWELLENGREBEL (62) himself says "this small fish is extremely voracious", and that "two specimens may eat 100 larvae in half an hour's time". These experiments were taken with animals freshly caught, which had therefore not fasted for any length of time.

Thus far the experiments. Besides these SWELLENGREBEL (62) examined the intestinal tract of 26 *Haplochilus panchax* (HAM. BUCH.) captured in sea fish-ponds in which a great many larvae of *Myzomyia rossii* GILES occurred. In the alimentary canal of only 2 of these he found remains of Anopheline larvae; the intestinal tract of 15 individuals contained other animal food, whilst the alimentary canal of the remaining fish contained nothing but "vegetable matter" [1]). Furthermore SWELLENGREBEL (62) in a

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[1]) It is not clear to me me what SWELLENGREBEL (62) means here by "vegetable matter". *Haplochilus panchax* (HAM. BUCH.) is a pure carnivore, feeding exclusively on live animals. After reading the article by SWELLENGREBEL (62) discussed here I examined the intestinal contents of 84 more kepala timah. Only in *one* instance did I find any vegetable matter, namely a few small fragments of *Chaetomorpha*-threads in the intestinal tract of a kepala timah which had a. o. eaten Gammaridea. Now these Gammaridea build dwelling-tubes of all sorts of fine vegetable matter, among which also *Chaetomorpha*-threads. These fragments of *Chaetomorpha*-threads had therefore probably been consumed together with the Gammaridea.

definite case found many kepala timah and very many larvae of *Myzomyia rossii* GILES and of a *Culex* species together in a salt-water ditch with a dense floating *Enteromorpha* vegetation.

Finally in two cases he was able to observe a number of *Haplochilus panchax* (HAM. BUCH.) in their natural milieu, into which he introduced a quantity of mosquito larvae. Only twice did he then see a mosquito larva devoured by a kepala timah, whilst generally the fish did not care at all about the mosquito larvae, not even when they got right in front of their mouths. Nor did the alimentary canal of a few of these kepala timah caught among the mosquito larvae put out there contain any of those larvae, but only remains of "*Daphnia*", "*Cyclops*" and "*Heliozoa*".

From the preceding SWELLENGREBEL (62) thinks he ought to infer that "in salt water not much good is to be expected from the action of fish" (scil. *Haplochilus panchax* (HAM. BUCH.)).

Now I must begin by pointing out in the first place that the experiments and the observations just mentioned do not tally very well together.

On the strength of experiments in which nothing but mosquito larvae were put before recently captured *Haplochilus panchax* (HAM. BUCH.), SWELLENGREBEL (62) concludes that this little fish is "extremely voracious". On the other hand we can only deduce from SWELLENGREBEL's (62) interpretation of his observations, that he supposes that (in salt water) the kepala timah even when the milieu in which it lives contains a great many mosquito larvae, does those larvae little harm, but feeds mainly on other small aquatic animals.

Now it seems to me the height of improbability that a fish in its natural haunt should despise another animal for food which is always present there in great numbers, but that on the contrary it should devour in captivity, great quantities of the same animal immediately after being captured.

I may also remark the following concerning SWELLENGREBEL's (62) observations. The simultaneous presence of kepala timah and great numbers of mosquito larvae is by no means a conclusive fact, for the possibility always remains that but for the presence of the little fish the numbers of mosquito larvae in the same breeding place would have been far greater still.

Nor does it seem to me a very telling fact that *Haplochilus panchax* (HAM. BUCH.) was n o t s e e n, or rather was o n l y t w i c e s e e n to devour a mosquito larva. To begin with I am in a position to put over against this that at my laboratory for more than a year we regularly saw *Haplochilus panchax* devouring great quantities of mosquito larvae, in an aquarium which was in biological equilibrium and in which there were beside a tangle of *Chaetomorpha*, *Najas falciculata* R. BR. and some *Enteromorpha*, in addition to mosquito larvae and pupae also a great many Gammaridea, Copepods, Cladocera, Ostracods, Hydroporines, *Sphaerodema*'s, Nudibranchs etc. etc.. In the second place SWELLENGREBEL (62) does not mention at all that he saw the kepala timah consuming other animals than mosquito larvae. The only two animals of which he states that he saw them devoured by *Haplochilus panchax* (HAM. BUCH.) in natural surroundings happen to be two mosquito larvae.

SWELLENGREBEL (62) says that he "repeatedly observed a *Haplochilus* almost to touch with its nose a larva without doing it any harm".

In this connection it may be useful to quote the two following passages from HILDEBRAND (53) who worked with *Gambusia affinis* (BAIRD and GIRARD), a Cyprinodontid whose usefulness in destroying mosquito larvae in aquaria and fountains was already well known.

HILDEBRAND (53) then writes: "Placed another larva" (scil. an *Anopheles* larva) "in open water among fish" (scil. *Gambusia affinis* (BAIRD and GIRARD)). "This one too lay perfectly still, drifting like a small stick, "while fish swam all about, nosing it a time or two, but apparently not "detecting that it was alive and something to eat. Finally it drifted near a "tuft of grass and with a surprisingly quick movement it swam into the "vegetation. . . . .

. . "These feeding experiments, which were repeated many times, demon-"strated that the protective instinct in mosquito larvae is highly developed. "It was shown many times that the only protection an *Anopheles* larva has "from fish in open water is inactivity. When the larva thus drifts along fish "evidently mistake it for an inanimate object, for, as already shown, they "may swim all around it for several minutes, even touch the larva with "the snout and yet not discover that it is food".

Further it is perhaps worth mentioning that in the examination of the stomach contents of many hundreds of sea-fish feeding on plankton it became apparent to me that these fish at least by no means eat continually, but that beginning to feed at a given moment they continue doing so until their stomach is closely packed, and then take a while to digest, during which time no fresh food is taken. Something similar was exhibited by the kepala timah described in Chapter VI which had stuffed themselves cramful of Nereidae.

It moreover does not seem impossible to me that the kepala timah in natural surroundings, if perceiving the presence of the observer, would often be shy to take any food that has just been put into the water by that observer.

There now remains only the observation by SWELLENGREBEL (62) concerning the contents of the alimentary tract of the 26 kepala timah examined by him. In Chapter VI we have already seen that in the Batavia empangs the kepala timah feed not only on mosquito larvae and pupae but also on all sorts of other small and sometimes a little bigger (Nereidae) live animals occurring in those empangs, and even also on live terrestrial animals such as ants which have accidentally dropped into the water. This of course is no matter of wonder, since it would be a far more surprising specialization if the kepala timah, living amidst all the small aquatic animals occurring in the empangs, should gobble up none of them except only the mosquito larvae and pupae.

Furthermore in my examination of over 100 intestine-contents of as many kepala timah I invariably found in them Anopheline larvae and pupae or remains of these. The case where SWELLENGREBEL (62) did not find remains of Anopheline larvae in more than 2 out of 26 kepala timah therefore certainly does not represent the normal proportions, at least for the Batavia empangs.

Consequently whereas the result of SWELLENGREBEL's (62) experiment with *Haplochilus panchax* (HAM. BUCH.) fits entirely with my amply expounded views of the importance of this little fish as an eradicator of mosquito larvae and pupae, SWELLENGREBEL's (62) observations just mentioned do not induce me to modify these views.

From a few experiments made with *Ophiocephalus striatus* BL. and *Dangila cuvieri* C. V. kept in 3 L. glasses or in 10 L. tins SWELLENGREBEL (62) further supposes the conclusion warranted that a mechanical protection of the Anopheline larvae and pupae by floating and submerged water plants does not exist. According to him the swarming presence of those larvae and pupae in the very places where there are also floating and submerged water plants is due exclusively to the circumstances that 1° among those plants there always live numerous other small animals also preyed upon by the fish and which therefore partly divert the attention of the latter from the mosquito larvae and pupae, and 2° that the water-plants supply the food of the mosquito larvae.

I can agree with the statement sub 1°; as to the remark sub 2° I have already said above that I am quite willing to agree that, apart from the mechanical protection offered to the mosquito larvae and pupae by the floating algal masses and by the submerged vegetation reaching up to just beneath the surface of the water, the conditions of life for the Anopheline larvae and pupae may perhaps be more favourable in yet many other respects, a. o. as regards food, amid the submerged vegetation than in open pond water. Yet it is apparent that too much importance should not be attached to this in view of the enormous production of mosquitos observed by Mr. VAN BREEMEN and myself in the ponds of Heemraad Oost where the submerged or floating masses of water plants were entirely missing, nay in which to the naked eye not a single alga-thread nor a blade or leaf was to be perceived.

Furthermore I would not like to conclude, as SWELLENDGREBEL (62) does from the few experiments taken with *Ophiocephalus striatus* BL. and *Dangila cuvieri* C. V. under circumstances widely different from the natural conditions of life of those animals, that "the protection afforded by the plants" (scil. floating and submerged water plants) "is not a mechanical one." It seems to me superfluous to go any further into this matter now.

As stated before (page 261) one can easily convince oneself at the Batavia empangs of the fact that at least the dense compact conglomerates of water plants, consisting in the first place of *Chaetomorpha*, which are to be seen in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plates VII, VIII, IX, XI, XIV, XV, XXII and XXIII) mechanically and very greatly protect the Anopheline larvae against *Haplochilus panchax* (HAM BUCH.).

I have already mentioned in a few passages that the larvae and pupae of the dangerous malaria-transmitter *Myzomyia ludlowi* THEOBALD, and of *Myzomyia rossii* GILES, which if perhaps not quite innocuous, is at least far and far less dangerous, are found in immense numbers in the Batavia empangs. Compared with those myriads the numbers of a few other species of Anophelines also sometimes produced by the Batavia empangs are a vanishing quantity (cf. VAN BREEMEN ([48]), ([59])).

Now in the first place the investigation carried out by Mr. VAN BREEMEN and myself disclosed the fact that there is a great difference between *Myzomyia ludlowi* THEOBALD and *Myzomyia rossii* GILES in the way they react upon the great increase in the salinity of the pond-water such as may take place in the course of a dry East-monsoon (cf. Chapter II).

We made this discovery in October 1918. The empangs of the western extremity of the Batavian zone of marine fish-ponds from Muara Karang to Pekulitan inclusive, as a matter of fact produced no more *Myzomyia ludlowi* THEOBALD after June or July 1918, but continued to produce still large quantities of *Myzomyia rossii* GILES. The ponds of Heemraad Oost and Heemraad on the contrary continued also in the second half of 1918 to produce besides *Myzomyia rossii* GILES also and continually large numbers of *Myzomyia ludlowi* THEOBALD (cf. VAN BREEMEN ([59]), Table VI). On visiting those ponds of Heemraad and Heemraad Oost on October 22nd 1918, we found that whilst the ponds of the western extremity of this part of the Batavia empang-belt were altogether dry, the empangs situated nearer the mouth of the Gunung Sahari Canal contained the normal quantity of water, in which were growing besides *Enteromorpha* and plenty of "tay-ayer" (cf. Chapter IV) also a very great quantity of *Najas falciculata* R. BR.. We had learned before that with the strong increase of the salinity in the empangs in the western half of the Batavia empang-region (near Muara Karang, Fluit etc.) since the end of June 1918, *Najas falciculata* R. BR. had disappeared from those ponds (cf. Chapter IV). Hence we were not surprised to find on October 22nd 1918 that the water of the ponds of Heemraad Oost which were still producing many *Myzomyia ludlowi* THEOBALD, had a far lower salinity than most of the other Batavia empangs at the same time.

The salinity of three samples of water collected that day from those ponds near Heemraad Oost, containing *Najas falciculata* R. BR., was 11.5, 13.5 and 15.4 $^0/_{00}$. These low salinities were connected with the fact that water of a low salinity could be admitted into those ponds from the mouth of the Gunung Sahari canal (cf. Chapter II).

We accordingly observed that most of the Batavia empangs in which the salinity had risen after the end of June 1918 to a point far above that of sea-water, produced no more *ludlowi* in the latter half of 1918, whilst on the other hand the ponds of Heemraad Oost in which the salinity continued even then far below that of sea-water, went on producing *ludlowi*.

It was this observation that was really the inducement of our collecting the data laid down in Table IV, which data have already partly come up for discussion in Chapters II to VI and have been further elaborated in Tables V to XI.

Table V arranges the salinities and the quantitative data concerning the Anophelines caught by means of the mosquito-nets or emerged from the collected larvae and pupae, 1° topographically, that is, according to the particular part of the Batavia empang zone where they were collected; 2° in the order of the salinities. In order to render the nightly catches in mosquito-nets mutually comparable they have wherever necessary been computed out for 10 M^2 of the surface area of the more or less dense submerged vegetation, in connection with the fact, as communicated above, of 10 nets being usually set simultaneously in one breeding-place. For each 10 ‰ of the salinity the reader then finds computed the average number of ♀♀ of *Myzomyia ludlowi* THEOBALD and of *Myzomyia rossii* GILES captured per 10 M^2 and per night. Only in the case of the data collected for salinities between 20 and 24.9 ‰ and between 25 and 29.9 ‰ the Anopheline averages have been computed for the just mentioned classes of 5 ‰ of the salinities. I did this after I had perceived that with salinities between 30 and 40 ‰ far fewer *ludlowi* were produced by the Batavia empangs than with salinities ranging from 20 to 30 ‰. It is evident that the object of this subdivision was to find out whether a considerable diminution of the production of *ludlowi* could be ascertained already when the salinity rose above 25 ‰. These Anopheline-averages have then been put together in Table VII A and B. In these Tables a computation has been made in two ways for the several classes of 10 ‰ or 5 ‰ salinity, of the average Anopheline production per 10 M^2 and per night for the whole of the Batavia empang belt; scilicet in the first place by averaging again, for the divers 10 ‰ and 5 ‰ salinity-classes, the averages for the various parts of the whole Batavia empang zone; and in the second place by each time striking the average between all the data collected throughout the entire Batavia zone of marine fish-ponds for the several 10 ‰ and 5 ‰ salinity classes.

From the nature of the case no averages could be determined of the data occurring in Table V relative to the Anophelines emerged from the larvae and pupae collected from the empangs, as the separate catches of larvae and pupae are not mutually comparable. For it goes without saying, the hunting for pupae and larvae was not always done in the various breeding-places with the same number of coolies, nor with the same concentration of purpose (supervision!) and not always for the same length of time. Of these latter data I have consequently given in Table V only the totals for each 10 ‰ (or 5 ‰) salinity class. In order to furnish a basis for comparison I have subsequently expressed in Table IX the totals of the emerged ♀♀ of *ludlowi* in percentages of the totals of the emerged ♀♀ of *rossii* in other words I have calculated how many female *ludlowi* had emerged per 100 female *rossii*, first for the different parts of the Batavia marine fishpond zone, and next for the whole of that zone, for the several 10 ‰ and 5 ‰ salinity classes.

For further comparison I have similarly put down in Table IX also for the totals of the mosquito-net catches (cf. Table V) the number of *ludlowi* ♀♀ proportionately to 100 *rossii* ♀♀. I resolved upon this after I had become convinced that, even when the salinity rose as high as nearly 85 ‰ no diminution of the empang production of *rossii* was to be observed, in other words that in sharp contrast to what obtains for the production of *ludlowi*, the figures for the production of *rossii* are independent of the salinity, within the limits of the salinities recorded in the series of observations of Tables IV — XI (3.4 ‰ — 84.6 ‰).

The totals for *ludlowi* and *rossii* ♀♀ in Table IX which belong together, I have each time placed one over the other, divided by a horizontal line. On dividing the number placed above the line (the total number of ♀♀ of *ludlowi*) by the number below the line (the total of *rossii* ♀♀) and multiplying the quotient by 100, the result is the figure placed after the horizontal line and the following symbol =, which therefore shows the number of *ludlowi* ♀♀ per 100 *rossii* ♀♀.

In conclusion I have put together in Table XI the averages and other resultant figures, relating to the entire Batavia empang zone, from Tables VII A, B and IX.

The Tables VI, VIII and X correspond respectively with the Tables V, VII and IX, with however this difference that whereas in the latter three tables the data have been arranged topographically and in the order of the salinities, in the three former tables the arrangement of the data is topographical and chronological. Moreover I have not calculated any figures relating to the whole of the Batavia sea fish-pond zone in the Tables VIII and X, whilst this has been done in Tables VII (A and B) and IX. For, since the salinity, which has a preponderating influence on the size of the *ludlowi*-production, may differ widely in different parts of the Batavia empang belt during the same month (cf. Chapter II, Table VI and Table VIII), there would be no sense in attempting to compute mutually comparable final monthly figures such as monthly averages for the whole of the Batavia empang region. There is consequently no Table XII to correspond with table XI.

We may now proceed to a closer consideration of the Tables V to XI.

From Table VII (A and B) it is manifest that the *rossii*-production of the empangs observed by us, whose magnitude is from the nature of the case determined by the conjuncture of a great many conditions, was considerably higher when the salinities were between 40 and 84.6 $^0/_{00}$ than when the salinities were below 40 $^0/_{00}$, so that to put it in the mildest form, there is no ground whatever for concluding that the increased salinities should have an unfavourable influence on the production of *rossii*. Contrarily the *ludlowi*-productions of the same milieu at salinities above 25 $^0/_{00}$ were considerably smaller than when the salinity was lower. Moreover the catches by mosquito nets never yielded a *ludlowi* mosquito when salinities exceeded 42.8 $^0/_{00}$.

Concerning this latter question a further comparison of the Tables VII, V and IV teaches us that the catches by means of mosquito-nets effected when salinities ranged between 40 and 49.9 $^0/_{00}$, for which totally 145 nets were set in 24 different places in the Batavia empangs, yielded 3082 [1]) female *rossii*, but only 4 [1]) *ludlowi* females, of which 4 *ludlowi* females 3 were caught when a salinity of 40.0 $^0/_{00}$ was marked and 1 when the salinity was 42.8 $^0/_{00}$.

Furthermore a comparison of Tables VII, V and IV shows that at salinities upwards of 42.8 $^0/_{00}$ the catches with mosquito- nets made in 24 different places in the marine fish- ponds near Batavia, for which totally about [2]) 144 mosquito nets were set, yielded 4211 *rossii* females as against no *ludlowi* females at all.

I have thought it desirable just to mention these original, not yet reduced figures from Table IV because they show that my conclusions derived from the captures in mosquito-nets are based upon an ample material of facts.

I have just said that it appears clearly from Table VII (B) that there is no ground for concluding to an unfavourable influence of the increase of the salinity on the production of *rossii*. On the other hand I am certainly not disposed to ascribe the very high figures for the *rossii*-production at salinities between 50 and 69.9 $^0/_{00}$ to any favourable influence of those salinities as such. As we shall see further down we must assume that this great production of *rossii*, occurring in conjunction with high salinities, was due to the fact that at the times and in the places where

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[1]) It may probably be superfluous to point out that with these figures 3082 and 4, correspond the figures 4902 and 5 in Table VII. For Table VII was derived from Table V, in which latter table the net-catches of Table IV are all expressed per 10 M^2 (and per night). The figures mentioned here, scil. 145 nets, 3082 *rossii* females and 4 *ludlowi* females are deduced from the figures in Table IV concerning the catches in mosquito-nets, not yet reduced to the units of Table V.

[2]) "about 144", because (cf. Table IV) at the time it was omitted to note down how many nets had been set in the ponds near Jaagpad on November 16th, 17th, 20th and 21st. There were probably six or at all events more than 4 nets each time. I have counted 5 mosquito-nets for each of these four catches.

it was observed, all sorts of circumstances exerted a heightening influence on that production. It would therefore appear to me that from the data collected by Mr. VAN BREEMEN and myself the inference ought to be made, as I have already had occasion to remark, that, within the limits of the salinities observed (3.4—84.6 $^0/_{00}$), the size of the production of *rossii* is independent of the salinity.

We ought not to be surprised to find that for the different parts of the Batavia empang region the figures expressing the average *ludlowi* production per 10 M^2 and per night do not always exactly in the same way follow the modifications of the salinity (cf. Table VII A). It stands to reason that the magnitude of the *ludlowi*-production does not depend exclusively on the salinity, but is also dependent on a great many other conditions. Most of those other conditions will doubtless influence the magnitude of both the *ludlowi*-production and the *rossii*-production equally. Hence the combined effect of those other conditions must in my opinion find expression in the figures of Table VII B, stating the average production of *rossii* per 10 M^2 and per night, which latter production, I venture to repeat, is not influenced, within the limits of the salinities observed, by the variations of the salinity.

The preceding may if necessary be rendered still clearer by the following example. Taking the case of Heemraad Oost and placing for the different salinity classes side by side the figures denoting the average numbers of *ludlowi*-females and of *rossii*-females produced per 10 M^2 and per night, we get the following:

Salinity:	*ludlowi* ♀♀:	*rossii* ♀♀:
0 — 9.9 $^0/_{00}$	76	19
10 — 19.9 $^0/_{00}$	71	30
20 — 24.9 $^0/_{00}$	21	95
25 — 29.9 $^0/_{00}$	25	220
30 — 39.9 $^0/_{00}$	$11^1/_2$	157

For *ludlowi* we see the numbers of females produced per 10 M^2 and per night decreasing regularly as the salinity rises. Only at salinities between 25 and 29.9 $^0/_{00}$ not fewer, but rather more *ludlowi* ♀♀ were produced than at salinities between 20 and 24.9 $^0/_{00}$. But if we consider how many more *rossii* ♀♀ were produced at salinities between 25 and 29.9 $^0/_{00}$ than at salinities between 20 and 24.9 $^0/_{00}$, I am inclined to assume that in the cases when the salinities between 25 and 29.9 $^0/_{00}$ were observed, the conditions for the production of both species of Anophelines were on the whole so much more favourable than in the cases when the salinities between 20 and 24.9 $^0/_{00}$ were observed, that in spite of the influence of the salinity working in the opposite direction, the *ludlowi*-production at 25—29.9 $^0/_{00}$ was yet somewhat greater than at salinities between 20 and 24.9 $^0/_{00}$.

In contradistinction to what was shown by the *ludlowi* females, the number of *rossii* females produced in this case continually increased with the increase of the salinity from 0 to 29.9 $^0/_{00}$. On this ground it seems to me that the influence of the rise of the salinity on the production of *ludlowi* was as a matter of fact greater than appears at first sight from the above figures concerning Heemraad Oost.

It also stands to reason that it is not possible for me, whenever the average number of *ludlowi* ♀♀ produced per 10 M² and per night does not vary just so as could be expected in connection with the salinity variations alone, to specify exactly why this is so, especially not when the *ludlowi* production at different salinities differs but little, as for instance in the case of the ponds near Jaagpad. For of course the exact magnitude which in any specified case the *ludlowi* production must attain is the resultant of the conjuncture of a great many factors whose influence to a great extent escapes our observation.

However the regular decline of the *ludlowi* production in connection with the gradual rise of the salinity is unmistakably expressed in the figures collected in Table XI which deal with the entire Batavia empang district.

In my opinion the figures mentioned after **a** in Table XI have the best claim to give a true picture of the average production of *ludlowi* females per 10 M² and per night for the whole of the Batavia empang belt at different salinities. As stated in Table XI these averages to be found after **a** were obtained by determining for each salinity class the average of the local averages calculated for the different parts of the Batavia empang zone. By doing so an equal influence is given to each local average in determining the final average of the production for the entire region.

Now in Table XI we see these averages placed after **a**, denoting the production of *ludlowi* ♀♀ per 10 M² and per night, gradually decreasing as the salinity rises. The average production is greatest at the lowest salinities, and it is reduced to nihil at a salinity a little over 40 $^0/_{00}$ (scil. at 42.8 $^0/_{00}$ (cf. Tables VII and V)).

According to the figures placed after A in Table XI simply denoting the averages derived at once from all the data collected in the entire Batavia empang zone at a given salinity, the *ludlowi*-production would be at its maximum not at the very lowest salinities, but at salinities between 10 and 19.9 $^0/_{00}$. Also the figures put down in Table VII in respect of Pekulitan and Pegantungan seem to point in the same direction. After a careful study of Table V it has become clear to me that the fact of the *ludlowi*-production being, at least in some cases such as those of Pekulitan and Pegantungan, smaller at salinities between 0 and 9.9 $^0/_{00}$ than at salinities between 9 and 19.9 $^0/_{00}$, should be accounted for as follows:

The lowest salinities between 0 and 9.9 $^0/_{00}$ I found, as may be readily understood, especially in the early part of the year after the heavy showers of the West monsoon had fallen.

Except in the ponds of Heemraad and Heemraad Oost into which water of low salinity can be continually admitted from the mouth of the Gunung Sahari canal (cf. Chapter II), salinities below 10 $^0/_{00}$ were not observed by us in the latter half of 1919 (cf. Tables V and VII).

Salinities comprised between 10 and 19.9 $^0/_{00}$ on the other hand generally occurred somewhat later in the year than salinities between 0 and 9.9 $^0/_{00}$. Thus in the ponds near Fluit, Pegantungan and Pekulitan in July 1919 I found almost exclusively salinities between 10 and 19.9 $^0/_{00}$, whilst salinities below 10 $^0/_{00}$ though observed in these ponds in March and April and even in May and June, no longer occurred there in July.

Now it appears from many examples that, at least during the first seven months of 1919, generally speaking more *ludlowi* were produced at a specified salinity according as that salinity occurred later in the year. Below I have put together a few of those examples borrowed from Table V:

Salinity:	Ponds near:	Time of the year: (1919)	Average number of *ludlowi* ♀♀ produced per 10 M^2 and per night.
0—9.9 $^0/_{00}$	Pekulitan	March 20—23	7
„	„	May 28 — June 25	$34^1/_2$
„	Jaagpad	February 6 — 21	0
„	„	Juni 3 — 6	25
„	Heemraad	April 23	6
„	„	July 24 — 25	460

A similar example, likewise borrowed from Table V, but referring to salinities between 10 and 19.9 $^0/_{00}$, is furnished by the following figures relating to the empangs near Jaagpad. These ponds produced in 1919, at the salinities mentioned:

between April 10th and 22nd: an average of 0 ludlowi p. 10 cM^2 and p. night;
„ July 4th „ 18th „ „ „ $28^1/_2$ „ „ „ „ „ „.

Trying to give an explanation of the fact that on the whole more *ludlowi* are produced at the same salinity in June and July than let us say in February, March and April, I must start by pointing out that, as I described in Chapter II, the low salinities are produced suddenly, generally in January or February in consequence of the heavy West-monsoon showers, accompanied or not by river-spates and inundations. In the period immediately preceding the falling of those West-monsoon rains the *ludlowi* production, at least in our case, that is in the autumn of 1918, had very markedly decreased in the greater part of the Batavia empang region in connection with the very strong increase of the salinity and had even been reduced to 0 in not a few cases.

Furthermore VAN BREEMEN (59) says (page 94, Table VIII) that in the autumn of 1918 far fewer *ludlowi* imagines were captured in the kampongs situated west of the old city (Kotta) of Batavia and south of the empangs that hardly produced any more *ludlowi*, than there were caught in the kampongs situated south of the ponds of Heemraad and Heemraad Oost, which ponds still contained water of a low salinity and therefore still produced *ludlowi*.

It is true that VAN BREEMEN's (59) figures concerning the mosquitos captured in the houses are strictly speaking just as little mutually comparable as the larvae-captures discussed before, so that they do not really furnish conclusive data respecting the actual numbers of *ludlowi* imagines present.

Nevertheless I think we may safely assume that in the opening months of 1919, particularly in the western part of the Batavia empang zone, where the *ludlowi* production had been practically reduced to nil in the latter half of 1918, and where outside the empangs no other *ludlowi* breeding-places occurred, there were no longer so many *ludlowi* females present that could go and lay their eggs in the empangs, in which the salinity had suddenly gone down again very low, but where no more *ludlowi* larvae had been present for a considerable time. Hence it must in the natural course of things have taken some time before the *ludlowi* production reassumed important proportions, after the sudden lowering of the salinity.

Secondly it should be considered that during the West monsoon and, as long as considerable rains continue to fall, also in the succeeding spring, certainly a smaller percentage of the *ludlowi* mosquitos that have been produced will succeed in laying their eggs in the empangs than will be the case later in the year when the weather has become more favourable to the mosquitos.

And in the third place there is the question of the submerged vegetation. I have explained above how the conglomerates of submerged plants either reaching up to the surface of the water or floating on it conduce vastly to the production of Anophelines. Furthermore I have described in Chapter IV how at the end of the year and at the beginning of the new year the submerged vegetation, originally reaching up to the water's surface or floating on it, has been in part consumed by the bandeng and that an other part of it has sunk to the bottom after the falls of rain, so that just towards the end of January and the early part of February after the capture of the bandeng for the Pasar Malem [1]) the development of the submerged vegetation is at its lowest. Subsequently a fresh submerged vegetation begins to develop in the course of the next spring in connection with which the conditions become gradually more favourable to the Anopheline larvae. Of course the submerged vegetation develops earlier in one year than in another. Thus in the spring of 1919 the submerged

[1]) cf. note page 196.

vegetation developed later and generally speaking a little less luxuriantly than in the spring of 1918.

From the above it seems to me sufficiently proved that we have no right to conclude from the figures of Table VII A relating to Pekulitan and Pegantungan, that the optimum for the *ludlowi*-production is situated at salinities from 10 to 19.9 ‰. On the contrary everything points to the conclusion that in proportion as the salinity is lower the conditions, ceteris paribus, are also more favourable to the production of *ludlowi*. Hence also the ponds of Heemraad and Heemraad Oost which contain water of a comparatively low salinity all the year round and in which I accordingly found even in August and September salinities below 10 ‰, ponds consequently to which a great part of the argumentation just offered does not apply, exhibited the greatest production of *ludlowi* at the lowest salinities (cf. Table VII A). This explains at the same time why in Table XI the greatest production of *ludlowi* for the averages placed after A is found at salinities from 10 to 19.9 ‰, but for the average placed after a at salinities from 0 to 9.9 ‰. For from Table VII A which shows once more how the two series of general averages, concerning the whole empang zone were calculated, it is certainly apparent, that in the averages after A in Table XI the great *ludlowi* captures of Heemraad and Heemraad Oost, in connection with the many times that in these ponds nets were set on one side over water of salinities from 0 to 9.9 ‰ and on the other side over water of salinities from 10 to 19.9 ‰, are expressed insufficiently for the salinities from 0 to 9.9 ‰, but too highly for the salinities from 10 to 19.9 ‰.

The regular, though small, increase of the *ludlowi*-production in the ponds near Jaagpad in proportion as the salinities between 3.4 and 29.9 ‰ were higher and the fact that the ponds near Fluit exhibited an increased *ludlowi*-production at salinities from 30 to 39.9 ‰, compared with the production at salinities from 0 to 9.9 and from 10 to 19.9 ‰ (cf. Tables V and VII A), must be accounted for likewise by the fact that during the prevalence of the higher salinities a number of circumstances were generally more favourable to the *ludlowi*-production, which for that matter was never great in these cases, than during the prevalence of the lower salinities.

The averages printed after B and b in Table XI relating to the *rossii*-production serve for comparison with the corresponding figures concerning the *ludlowi*-production mentioned after A and a.

The production of *rossii*, fairly constant at salinities below 25 ‰, suddenly increases rather importantly at salinities between 25 and 29.9 ‰. This increase of the *rossii*-production then continues fairly markedly as the salinities increase up to 69.9 ‰. I have already, though in somewhat different words, pointed out how this phenomenon must doubtless be connected with the fact that when we made our observations the many other conditions apart from salinity which influence the size of the mosquito-production, were more favourable in proportion as the salinities were higher, at least as long as they remained below 70 $^0/_{00}$.

Hence it seems to me not impossible that the unfavourable influence exerted on the *ludlowi*-production by the rise of the salinity above 24.9 $^0/_{00}$ was counteracted by a number of other influences conducive to a high productivity, and is therefore not very strongly expressed in the averages behind A and a in Table XI.

Other important figures are those after AB and A′B′ in Table XI denoting the *ludlowi*-production expressed in percentages of the *rossii*-production, firstly for the females captured in mosquito-nets, and secondly for the females emerged from the larvae and pupae that were caught. These figures, the method of calculating which I have already explained in detail, are derived from Table IX, in which the Anopheline totals for the several 10 $^0/_{00}$ and 5 $^0/_{00}$ salinity classes have been collected and further elaborated.

The figures placed behind AB and A′B′ in Table XI tally remarkably well. They only deviate rather importantly for the salinities between 20 and 24.9 $^0/_{00}$. A glance at Table IX however accounts for this; for during the prevalence of the salinities just mentioned nets were indeed set in the ponds near Heemraad which produce so many *ludlowi*, but no larvae and pupae were collected in these ponds. Apart from this the almost exact correspondence of the figures after AB and A′B′ relating, in the same order, to the female mosquitos caught in the nets and to those emerged from the larvae and pupae collected, speaks for the reliability of the material collected by Mr. VAN BREEMEN and me. It proves at all events that the staff of the Batavia Public Health Service (Gezondheidsdienst) made few errors in determining the mosquitos in spite of the fact that, at least to me, it seems often rather difficult to distinguish the *ludlowi* and the *rossii* individuals from each other.

The fact that also in the case of the figures after AB and A′B′ in Table XI the greatest *ludlowi*-production corresponds with salinities between 10 and 19.9 $^0/_{00}$, and not with salinities below 10 $^0/_{00}$ is accounted for by the same explanation given above for the parallel fact regarding the averages placed after A in Table XI. For indeed both the figures appearing after AB and A′B′, and the averages recorded after A were directly calculated from the whole of the data collected in the entire Batavia empang region.

Table IX affords me little occasion for further observations. What this Table has to show is after all better expressed in Table VII. I have already explained before how Table IX only represents an attempt to cast the figures collected by the Public Health Service (Gezondheidsdienst) as to the *ludlowi* females emerged from larvae and pupae captured, which figures were not directly mutually comparable, into some shape which would allow of some measure of comparison.

It only remains for me to point out in a few words that it appears from Table IX (and Table V) that from larvae and pupae collected at the empangs in water of salinities between 40 and 84.6 ‰, against 3055 *rossii*-females only 2 *ludlowi* females emerged, one at a salinity of 41.3 ‰ and one at a salinity of 44.6 ‰. The latter case slightly shifts the limit of maximum salinity for the production of *ludlowi*, which as we have seen before was according to the catches in mosquito-nets at 42.8 ‰, and is now shifted to 44.6 ‰.

The data concerning the production of *ludlowi* and *rossii* by the empangs at salinities higher than 40 ‰ were obtained, as Table V shows, exclusively at the end of 1918 and for a small part also at the very beginning of 1919.

We were enabled to collect these data in consequence of the fact that 1918, at least after February, was a very dry year (cf. also Chapter II) as becomes apparent from the following table of data supplied by the Royal Magnetic(al) and Meteorological Observatory at Weltevreden, in which the figures denoting a fall of rain lower than the long period average are printed in italics.

Rainfall in millimetres.

I. Tandjong Priok.

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
19 years average	339	360	170	101	90	85	57	41	61	68	120	171
1917	355	*177*	*136*	*51*	*25*	*18*	59	*20*	98	107	*50*	223
1918	*317*	733	*59*	*61*	*39*	*17*	*41*	*6*	*0*	*43*	*109*	*134*
1919	*196*	464	181	*75*	136	*75*	2	63	65	*33*	*68*	*126*

II. Weltevreden (Observatory).

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
42 years average	318	323	207	136	111	99	70	43	75	116	148	191
1917	451	353	*163*	224	*55*	*49*	114	94	149	223	*78*	212
1918	321	657	*100*	*109*	*84*	*14*	*38*	*27*	*11*	*16*	*131*	*146*
1919	*205*	486	*169*	*124*	159	195	*25*	80	*15*	*108*	165	*90*

These figures exhibit a conspicuous difference between the second half of 1917 and of 1918. Whilst the second half of 1918 was very dry, there was in the second half of 1917 in the Batavia empang region a heavier rainfall than the average for many years. Accordingly in the autumn of 1917 the pond-water did not grow nearly so salt as in the autumn of 1918, in connection with which *ludlowi* were produced in the end of 1917 by various empangs which produced no more *ludlowi* at all in the end of 1918, as becomes apparent on comparing Table III with Table VI.

In Table III I have put together a few data which were collected towards the end of 1917 by Mr. VAN BREEMEN and Dr. B. C. P. JANSEN of the Medical Laboratory (Geneeskundig Laboratorium) at Weltevreden, and handed over to me by Mr. VAN BREEMEN. In Chapter II I have already mentioned how I obtained the salinity-figures of Table III by reducing the figures determined by Dr. JANSEN for the "amount of Na Cl". The Anophelines emerged from the larvae and pupae collected at the same time in breeding-places situated near one another in the same pond-system, were put together i.e. they were not kept apart for each breeding place. Hence in Table III are recorded each time for several salinities together the aggregate number of *ludlowi* and *rossii* females emerged.

In the following examples selected from Tables III and VI the difference here being discussed between the *ludlowi*-production in 1917 and in 1918 becomes clearly apparent:

Ponds near:	Time:	Salinity:			Emerged from larvae and pupae collected		
		lowest	highest	average	*ludlowi* ♀♀	*rossii* ♀♀	number of *ludlowi* ♀♀ per 100 *rossii* ♀♀[1]:
Muara Karang	22 XI'17	12.0 ‰	30.5 ‰	24.1 ‰	4	50	8
"	$^{15}/_{25}$ XI'18	42.2 ‰	62.6 ‰	53.6 ‰	0	625	0
Fluit	20 XI'17	14.0 ‰	27.0 ‰	21.7^{5} ‰	19	22	86
"	$^{5}/_{11}$ XII'18	44.6 ‰	84.6 ‰	58.1 ‰	1 (at 44.6 ‰)	507	0.2
Pekulitan	19 XI'17	19.5 ‰	24.0 ‰	21.5 ‰	11	31	35
"	$^{26}/_{30}$ XI'18	36.2 ‰	40.0 ‰	38.8 ‰	0	527	0

In Chapter II we saw (cf. also Table I) that just as in 1918, high salinities, ranging between over 40 ‰ and 74.5 ‰, also appeared in October and November 1919, at least in Mr. Görs's ponds near Muara Karang. In fry-ponds, which were however not in use at the moment, the salinity even rose as high as 93.2 ‰ on the 4th of November 1919.

From the rain figures given above it is clear enough that in respect of the influence of the East-monsoon on the *ludlowi* production in the empangs,

1) It will probably be superfluous to remark that it is not the absolute magnitude of the mosquito-figures that is in question here, but the proportion between the numbers of *ludlowi* and *rossii* females emerged.

1919 must have been intermediate between 1918 and 1917, probably a little nearer to the former year than to the latter.

We can now proceed to a closer study of Table VIII. In it is clearly expressed the very large production of *rossii* in November and also still in December 1918. Also in January and February 1919 the *rossii* production is still fairly large; after this however it gradually declines as time goes on, reaching a minimum in August 1919. In September 1919 the ponds near Fluit exhibit once more a larger production of *rossii*, this being then evidently the first indication of the new great autumnal production of *rossii*.

Table VIII shows clearly that the months of May-August 1919 were distinguished by the smallest production of *rossii*. The *ludlowi* production on the other hand was in the same months generally largest, as is likewise visible in Table VIII. In connection with this it only occurred in the months of April to September (1919), and, if we leave the ponds of Heemraad Oost and Heemraad out of consideration, only in May, June and July (1919) (cf. the figures concerning the ponds of Pekulitan, Antjol and Jaagpad in the Tables VIII and X [1]) that the *ludlowi* production was occasionally greater than the *rossii* production. On the other hand the greatest *ludlowi* production that we could observe occurred in exactly the same month as the greatest production of *rossii*, viz. in November 1918, and that in the ponds of Heemraad Oost in which, contrary to what had happened in most of the Batavia ponds in the latter half of 1918, the salinity had until that moment continued so low, that in the spot where the mosquito-nets were set, it only amounted to 13.1 ‰.

There is not in my opinion any reason for surprise on finding that a dry autumn like that of 1918, apart from the question of the salinity, is favourable to both the *rossii* production and the *ludlowi* production. For in no season of the year do so few mosquito-imagines fall victims to rain and wind and will consequently so many females be able to return to the breeding-places and lay their eggs there, as in a period when the East-monsoon no longer prevails forcefully and regularly and when very little rain comes down.

Apart from this it is clear enough that the differences of the annual course of the *ludlowi* and of the *rossii* production is almost entirely dominated by the fact that the *ludlowi* production is to a high degree dependent on the salinity whilst on the contrary the production of *rossii* is quite independent of this factor at least within the limits of the salinities observed. Only in consequence of the fact that the *ludlowi*-production is highly dependent on the salinity, the maximum *ludlowi* production is shifted to the middle of the year, and to be precise, in accordance with the influences discussed above (pages 276-278) to the latter part of the first half and the very beginning of the second half of the year. In places where the influence of the salinity

[1]) As remarked before Table X is related to Table VIII, as Table IX to Table VII. For this compare the discussion of Table IX on page 272.

partly fails, such as in the ponds of Heemraad Oost where the salinity keeps relatively low throughout the year, the autumnal maximum of mosquito production becomes immediately evident also for *ludlowi* (cf. Table VIII, Heemraad Oost). Mostly however, at least in a dry year, the autumnal maximum for *ludlowi* will be quite suppressed and even replaced by a very low minimum in connection with the high salinities which arise just then.

The phenomenon that the *rossii* production declines in the spring, together with the further fact that when, after a period of high salinities, low salinities occur again suddenly the *ludlowi* production does not immediately increase very greatly, may be confidently put down to the West-monsoon showers, the spring rains and the circumstance that the submerged vegetation reaches full development only gradually in the course of the spring.

Finally I have not been able to find an explanation for the fact that from May to August 1919 the *rossii* production kept diminishing slightly all the time. It is no wonder that a single point like that should remain unexplained; the number of factors influencing the magnitude of the *rossii* or the *ludlowi* production is from the nature of the case very great and many of them are likely to escape our notice for ever.

VAN BREEMEN (48) has demonstrated that what TERBURGH had been able to ascertain before for Sourabaya and Semarang, viz. that the kampongs on the North-coast of Java where a great deal of malaria occurs, mostly exhibit an increased mortality in the months of July, August and September; and that such mortality must be chiefly attributed to malaria, also holds good for Batavia.

From the above and from what is known concerning the great importance of *ludlowi* as a transmitter of malaria, the conclusion is certainly warranted that the increased mortality from malaria in July, August and September on the North-coast of Java, at least where the *ludlowi* breeding-places are marine fish-ponds, is undoubtedly intimately connected with the fact, apparent from Mr. VAN BREEMEN's and my investigation, that the *ludlowi* production of the marine fish-ponds reaches its maximum about the middle of the year, after which, at least in a year when a sufficiently dry East monsoon develops, it diminishes again very considerably in the autumn (September, October, November) and is sometimes arrested altogether.

Also SWELLENGREBEL (60) connects the increased rate of mortality from malaria in July, August and September with the fact which he observed at Semarang in 1918, just as CITROEN has done at Sourabaya (when?), that *ludlowi* occur very plentifully especially in the dry season [1]), to disappear again in October-December.

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[1]) "in the dry season"? "In the first part of the dry season" or "about the middle of the year" would probably be more correct here.

SWELLENGREBEL (60) furthermore records for Semarang an enormous increase of *rossii* mosquitos towards the end of 1918. With this he connects the fact that for various places on the North coast of Java beside the maximum malarial mortality in July, August and September another similar though smaller maximum is known at the beginning of the rainy season. If this view is correct, *Myzomyia rossii* GILES, even though its importance as a malaria-transmitter is very much less than that of *Myzomyia ludlowi* THEOBALD, would after all not be so innocuous as is sometimes assumed.

I wish to revert for a few moments to the enormous significance, frequently referred to in the above, of the ponds of Heemraad and Heemraad-Oost as *ludlowi* breeding places. In those ponds, as I remarked in the foregoing, the *ludlowi* production in the months of April up to and including September 1919 was greater than the production of *rossii*; as far as the remaining Batavia empangs are concerned this only occurred in 1919 in the ponds near Pekulitan, in June and July; in the ponds near Antjol, in May; and likewise in May in the ponds near Jaagpad, in these latter however it was only from the larvae and pupae collected that more female *ludlowi* than *rossii*-mosquitos emerged, whilst on the contrary more female *rossii* than *ludlowi* mosquitos were captured in mosquito-nets (cf. Tables VI, VIII and X) [1]).

Moreover at salinities between 25 and 29.9 $^0/_{00}$ an excess of the *ludlowi*-production over that of *rossii* occurred only in the ponds near Heemraad (cf. Tables VII and IX).

I do not venture to decide the question as to whether this great importance of the empangs of Heemraad and Heemraad Oost as breeding-places of *ludlowi* is connected solely with the fact that in these ponds the salinity even in the course of a very dry East monsoon always remains comparatively low, owing to which the fauna of the aquatic stages of *ludlowi* in these ponds can maintain itself throughout the year. It is not impossible that there may be yet other factors which for the present escape our notice.

The greatest *ludlowi*-production we met with amounted to 647 *ludlowi* females per 10 M^2 of the pond surface in one night. This was recorded on July 25th 1919, in the ponds of Heemraad, at a salinity of 9.3 $^0/_{00}$ (cf. Table V). The number of mosquito nets set on that occasion was 8, yielding together a harvest of 518 female *ludlowi* (cf. Table IV).

As regards the greatest production that we could record in each of the other parts of the Batavia empang region, this will be found, together with that of Heemraad, in the subjoined list, derived from Tables V and IV.

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1) As appears from Table VI in May 1919 larvae and pupae were only once collected in the ponds near Jaagpad. Mosquito-nets however were set there 9 times in that same month.

Ponds near	Date	Salinity	Number of *ludlowi* ♀♀ per 10 M^2 and per night	Number of mosquito-nets set out	Number of *ludlowi* ♀♀ actually caught
Heemraad. . .	25 VII '19	9.3 $^{0}/_{00}$	647.5	8	518
Heemraad-Oost.	21 V '19	10.0 $^{0}/_{00}$	289	10	289
Pekulitan . . .	28 VI '19	12.0 $^{0}/_{00}$	269	8	215
Pegantungan. .	17 VII '19	14.3 $^{0}/_{00}$	142.5	8	114
Jaagpad. . . .	24 V '19	26.8 $^{0}/_{00}$	120	10	120
Fluit.	8 IX '19	38.7 $^{0}/_{00}$	39	10	39
Luar Batang . .	29 III '19	11.5 $^{0}/_{00}$	27	7	19
Muara Karang .	6 V '19	9.7 $^{0}/_{00}$	12.5	8	10

As for the production of *rossii*, leaving aside the abnormal production of 17288 ♀♀ per 10 M^2 in one night, which as discussed before, we witnessed on November 15th, 1918 in ponds near Heemraad Oost at a salinity of 25 $^{0}/_{00}$, the following schedule records the maximum *rossii* production observed by us in each of the different parts of the Batavia sea-fish pond belt: [1])

Ponds near	Date	Salinity	Number of *rossii* ♀♀ per 10 M^2 and per night	Number of mosquito-nets set out	Number of *rossii* ♀♀ actually caught
Jaagpad	24 XI '18	59.2 $^{0}/_{00}$	1466	5	733
Heemraad Oost.	12 XII '18	26.9 $^{0}/_{00}$	1037	10	1037
Pekulitan . . .	29 XI '18	40.0 $^{0}/_{00}$	784	10	784
Muara Karang .	13 XII '18	46.9 $^{0}/_{00}$	564	5	282
Fluit.	12 IX '19	34.7 $^{0}/_{00}$	442	10	442
Heemraad. . .	19 IV '19	13.1 $^{0}/_{00}$	201	7	141
Luar Batang .	29 III '19 21 III '19	11.5 $^{0}/_{00}$ 26.5 $^{0}/_{00}$	170	7 7	119 119
Pegantungan. .	17 VII '19	14.3 $^{0}/_{00}$	80	8	64

The greatest production of *rossii* (apart from that observed at Heemraad on November 15th 1918), was consequently more than double the size of the greatest production of *ludlowi*.

It is a pity that up to the present, as far as I am aware, no figures have been collected in the Netherlands East Indies concerning the magnitude of the production of Anophelines by definite breeding places, which might be compared with our figures. Only in the work of Sir RONALD ROSS, K.C.B. (32)

[1]) Neither for *rossii* nor for *ludlowi* a maximum production of the ponds near Antjol is given here, because in those ponds a set of mosquito-nets was placed once only.

(page 165) mentioned in the foregoing, there is a record of the production in a marsh or a piece of flooded land in Mauritius, of 5062 individuals of the non-malaria-transmitter *Myzorhynchus mauritianus* DARUTY and d'EMMEREZ per 10.000 M^2 and per day. There being about as many males as females among these mosquitos (30 : 31), this production expressed in my manners only amounted to $2^1/_2$ Anopheline females per 10 M^2 and per night (or "per diem"). ROSS (32) himself says about this production observed by him, which is absolutely dwarfed by the Anopheline production stated by us for the Batavia empangs: "This output seems to have been rather large, as when the net was placed in another position the yield was much smaller".

Mr. VAN BREEMEN and I could observe that part of the mosquitos produced by the empangs perishes immediately after having emerged when in July 1918 we went to the ponds to watch the mosquitos emerging at evening. At the same time we observed that at least at the hour of our visit to the ponds ($6^1/_4$—$7^1/_4$ p. m.), many more mosquitos emerged one evening than an other, which for the rest tallies with the results yielded by our catches with mosquito-nets.

The mosquito pupae which we saw disclose were in the thin layer of water spreading over the thick masses of plants chiefly consisting of *Chaetomorpha* and reaching up to just beneath the surface of the water. After the imagines had emerged they continued for a little while sitting on the empty pupa-skin and then flew away. Swarms of swifts, shortly afterwards yielding place to bats then flew about over the ponds evidently feasting upon the newly emerged mosquitos as they flew away.

In the Netherlands East Indian literature on *Myzomyia ludlowi* THEOBALD one commonly finds it stated that the larva of this mosquito is chiefly found in salt water. Thus SWELLENGREBEL (45) says: "It" (scil. *Myzomyia ludlowi* THEOBALD) "generally prefers salt water", to which he adds that according to CHRISTOPHERS the larvae of *ludlowi* live exclusively in salt water. Elsewhere SWELLENGREBEL says (58) that the littoral breeding-places of *ludlowi* are mostly salt-water breeding places. In a third place the same author says (57): "Along the coast *ludlowi* is mainly an inhabitant of salt water, though it is also found in fresher" (sic) "water near the sea". MANGKUWINOTO (54) has the following passage: "The larvae" (scil. of *ludlowi*) "I only found along the coasts, principally in stagnant salt or brackish water containing water-plants, occasionally also in pieces of fresh water and unworked sawahs with stagnant water and water-plants, but usually in smaller numbers than were found in salt or brackish water".

Now it is a fact that in the littoral zone the *ludlowi* larvae live chiefly in breeding-places containing salt or brackish water. I would however point out that it does not seem impossible to me, in connection with, the results of Mr. VAN BREEMEN's and my investigation, that it might not be the salt, but one or more other conditions realised in the littoral salt-water breeding-places which makes these breeding places so suitable to *ludlowi.*

Should this be so there would be less matter for surprise in the occurrence of *ludlowi* in the interior of Sumatra in the fresh-water fish-ponds of Great *Mandailing (Penjabungan), Rao and Panti, and Padang* Sidempuan and in Lake Manindjau (cf. SCHÜFFNER, SWELLENGREBEL, SWELLENGREBEL-DE GRAAF and MOCHTAR ([55])). [1])

I will immediately add that, as SWELLENGREBEL ([58]) also says, it is not yet an established fact that the inland-*ludlowi* of Sumatra is identical with the common sea-coast *ludlowi*. In this connection I do not hesitate to concur with DAMMERMAN ([63]), who recently in a popular article expressed surprise at the fact that no one has thus far undertaken the experiment of starting from a given pair of Anophelines and raising their brood under various conditions. It might also be tried to construct frequency curves of some adequate countable characteristics for our common sea-coast *ludlowi* and for the inland-*ludlowi* of Sumatra, and likewise for the sea-coast *ludlowi* artificially reared in the Sumatra fresh water fish-ponds and for the inland-*ludlowi* of Sumatra *raised in the littoral brackish water breeding places. It* would then appear to what extent the common coast-*ludlowi* and the inland-*ludlowi* of Sumatra are identical.

I can not conclude this chapter without saying a few words about the measures which are required to make the Batavia empangs innocuous as sources of the malaria peril.

The draining dry of the marine fish-ponds along the coast of Batavia was resolved upon, mainly on the ground of the report made by Mr. VAN BREEMEN and myself ([52]) to the Commissioners of Public Health for the capital of Batavia (Gezondheidscommissie voor de hoofdplaats Batavia) on January the 3rd 1919, which report was published (with a great many misprints) in the City Gazette (Gemeenteblad) of Batavia No. 9, 1919 ([52]).

[1]) After this chapter had been written I visited in October and November 1921 the *ludlowi* breeding places in the interior of Sumatra. Before long I hope to report at length in an other publication upon the data and the material collected during this journey. The conditions under which the aquatic stages of the Sumatra inland-*ludlowi* lived in the fresh water fish ponds of Penjabungan, Padang Sidempuan and Rao resembled in many respects those under which the larvae of the common sea-coast *ludlowi* thrive in the Batavia empangs. Thick floating masses of filamentous Schizophyceae occurring in the fresh water fish ponds of Sumatra recalled the *Chaetomorpha* masses of the Batavia empangs. The part played sometimes in the Batavia empangs, when the salinity of the pond water is not too high, by *Najas falciculata* R. BR. was played in the fresh water fish ponds of Sumatra by *Hydrilla verticillata* CASP. and to a lesser degree also by *Najas sp.* and *Ceratophyllum sp.*.

In Lake Manindjau the occurrence of *ludlowi* larvae was also connected with the presence of floating masses of filamentous Schizophyceae and submerged masses of *Hydrilla verticillata* CASP. reaching up to the surface of the water. Outside the rushes of Lake Manindjau (cf. SCHÜFFNER, SWELLENGREBEL, SWELLENGREBEL—DE GRAAF and MOCHTAR ([55])) (= *Heleocharis plantaginoidea* W. H. WIGHT) I found far more *ludlowi* larvae than between them.

Even without having witnessed with one's own eyes how the malaria plague impresses its stamp of suffering on the whole existence of the population of the northern quarters of Batavia, it is possible, from the figures concerning spleen-index and mortality published by VAN BREEMEN ([48]) ([59]), to gain an impression of the great loss and waste not only of human happiness and human life but also of energy and productive capacity which this population is doomed to suffer under the leaden weight of the endemic malaria fed and nurtured by the empangs.

To such a state of things a final end can of course be put only by taking once for all radical and drastic measures, definitely rooting out the evil, such as the sanitation of the whole brackish water zone of Batavia which would include the draining of the empangs.

It has been supposed that the requirements of sanitation could be satisfied by the constantly kept up removal of the submerged vegetation, which as we saw in Chapter IV spontaneously develops in the ponds and is composed of floating masses of *Chaetomorpha* forming conglomerates with the other plants mentioned in Chapter IV, which float at or reach up to just beneath the surface of the water, and by regularly keeping the margins of the ponds clear of overhanging land plants projecting partly into the water and cutting them straight down. The bandeng now feeding in the Batavia empangs on the submerged vegetation just specified, would then have to be reared on "tay-ayer" only (cf. Chapter IV).

Apart from the question whether the Batavia bandeng rearers could really be successfully induced to feed the bandeng exclusively on, for example "tay-ayer" [1]), and no longer on the submerged vegetation floating at or reaching up to just beneath the surface of the water I highly doubt whether it would be practically possible to clear away all the time, in the whole Batavia pond district, 8.8 K.M. long and 0.8 to 1.8 K.M. wide, all the spontaneously and continually developing submerged vegetation before it begins to float or reaches the water surface by growing upward, and to keep all the pond margins clean. Moreover the question arises whether the empang-industry could bear the expenses of this continuous clearing away of the submerged vegetation and keeping clean of the edges of the ponds together with the cost of an effective supervision of this work. For surely these expenses should not be borne by the whole community but by the empang-industry itself.

But there is still more. By clearing away the algal vegetation it would be highly probable that *Haplochilus panchax* (HAM. BUCH.) would be deprived of the opportunity of reproducing itself in the ponds. For, as I said in Chapter VI, in the empangs I found the eggs of this little fish exclusively between the *Chaetomorpha* filaments to which they are

[1]) Besides with "tay-ayer" the bandeng could at all events be fed also with *Vaucheria*, which alga resembles *Chaetomorpha* certainly more than "tay-ayer" as a bandeng food, and of which, as related in Chapter IV, I have always seen the masses keep near the bottom and never rise to the surface of the water.

fastened by a special differentiation of the egg-membranes. These eggs of *Haplochilus panchax*, which do not float but sink, will certainly not be able to develop on the mud bottom of a pond deprived of vegetation.

And we have seen before how great may be the production of Anophelines of open empang-water without any vegetation, when *Haplochilus panchax* is absent from it! The complete clearing away of the submerged vegetation might accordingly lead to a result the exact opposite of the one intended.

It would however appear to me that the chance of the attempt ever being made to make harmless so extensive and dangerous a breeding place of malaria mosquitos close to a large town as the Batavia empang zone by the constant clearing away of the submerged vegetation floating at or reaching up to just beneath the water-surface and by keeping the pond margins clean, is very slight indeed.

In the second place the question has often been asked whether, upon the disappearance of the marine fish-ponds near Batavia, the *ludlowi* would not remove to other breeding places where they did not occur as long as the empangs were in existence. That this question would not be devoid of interest one might gather from the following words of SWELLENGREBEL (58):

"When there are no fish-ponds in a littoral district the *ludlowi* larvae "are found in breeding places, in which they are not found wherever "fish-ponds do exist. We will indicate this phenomenon by the name of "deviation of breeding places".

"When there are no fish-ponds in a littoral zone and they (or at least "sheets of water that are similar to them in their vegetation) are afterwards "formed, then the *ludlowi* disappears from the breeding places where they "formerly did occur, and concentrate on the new, more favourable ones: "a still clearer instance of the deviation of breeding places".

Now DAMMERMAN (63) has recently pointed out that for this so-called deviation of the breeding places of mosquitos sufficient proofs have never been given. Neither has it become clear to me on the strength of what data SWELLENGREBEL (58) thinks the conclusion warranted that in a littoral zone without fish-ponds *ludlowi* larvae are found in certain breeding places, where they would not be found in parts where fish-ponds do exist. He nowhere supplies systematic data on the strength of which such a far-reaching conclusion could be drawn with any certainty. On the contrary, from what he has said before, and likewise from VAN BREEMEN's investigations (48) (59), it is apparent that in a coastal region with salt water fish-ponds *ludlowi* larvae may still be met with outside the fish-ponds in other breeding places, albeit not in such great quantities as in the ponds themselves.

Furthermore it does not seem an easy thing to observe and ascertain with sufficient accuracy what SWELLENGREBEL (58) mentions in the second place, to wit, the total disappearance of *ludlowi* from an old, less favourably situated breeding-place, and the simultaneous appearance of *ludlowi* in more favourable breeding places newly formed in the vicinity, and to interpret such a phenomenon correctly.

Indeed we get very little information concerning the only case observed by SCHÜFFNER, which occasioned SWELLENGREBEL (58) to mention his second example of so called deviation of breeding places, in regard to the manner in which it was studied and to the observations made (cf. SWELLENGREBEL (58) page 47). SWELLENGREBEL (58) indeed refers for this case to page 4 (this ought to be p. 78) of an other publication (55), but in that place still less is said about the case in question.

Now I do not mean to assert that the idea of the deviation of breeding places is wholly illogical, but I only hold, with DAMMERMAN (63) that thus far no proofs and evidence have been adduced for the real existence of this so called deviation of breeding places. As there are no facts to go by, it is, however, difficult to further discuss SWELLENGREBEL (58) 's "deviation of breeding places".

At all events, at present, there are at Batavia no breeding-places that can in any degree be compared with the empangs as regards productivity of *ludlowi*-mosquitos.

VAN BREEMEN (59) (page 64) remarks that the number of larvae, captured in places outside the marine fish ponds, from which *ludlowi*-imagines developed is a vanishing quantity as compared with the masses of *ludlowi* larvae produced by the empangs.

Accordingly the incontrovertible fact remains that we shall never get rid of the endemic malaria plague of northern Batavia causing such a high mortality and paralysing the energy and productive capacity of the population, unless we start by making the whole Batavia brackish water zone harmless by a radical and efficient sanitation, including the draining-dry of the empangs.

I speak here of a radical and efficient sanitation of the whole Batavia brackish water zone and not only of the draining-dry of the empangs. Indeed, it should always be well borne in mind that not only the empangs but also all other pieces of brackish water containing floating algal masses and/or higher submerged aquatic plants, reaching up to the surface of the water, are genuine, highly dangerous breeding-places of *ludlowi*.

That pieces of fresh water, situated outside the Batavia brackish water zone and producing at present no *ludlowi*-mosquitos would ever become productive breeding-places of *ludlowi* in consequence of the draining of the empangs, seems, to say the least of it, highly improbable. At all events there are till now no facts known that could induce us to assume something like this.

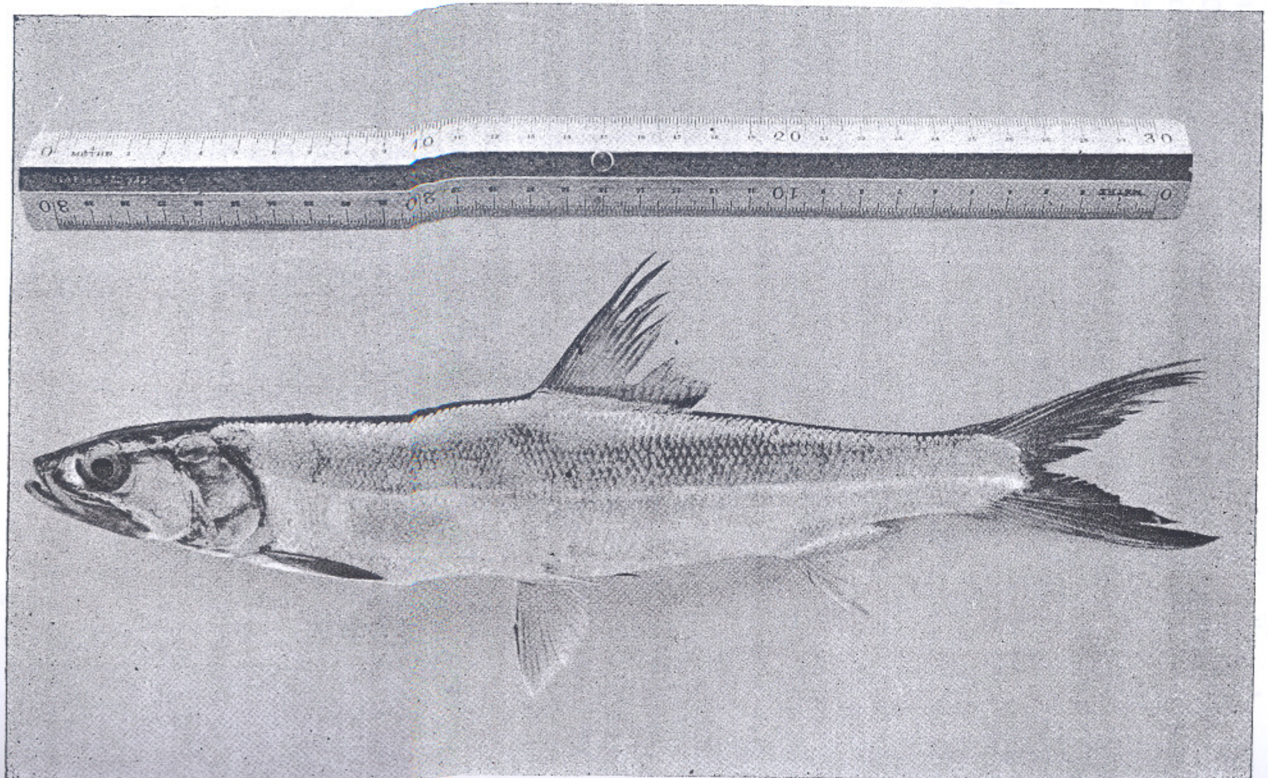


Photo no. 16. Bandeng lelaki (*Elops hawaiensis* T. REGAN) from the Batavia empangs.

CHAPTER VIII.

A few other animals of the Batavia empangs.

Besides the bandeng (*Chanos chanos* (FORSK.)) and the two species of *Haplochilus* discussed in Chapter VI, various other species of fish are regularly found in the Batavia empangs, the young brood penetrating from the coastal sea into the empang zone, especially when pond-water is being drained off into the sea, by swimming against the current and wriggling through the trellis-work partition (kereh) of the little sluice-gates (cf. Chapter V and photo 1, Plate VI). Of these other fishes VAN KAMPEN (25) enumerates the kakap (*Lates calcarifer* GTHR. = *Lates nobilis* C. V.); the belanak (various species = *Mugil spp.*); the bandeng lelaki (*Elops hawaiensis* T. REGAN, cf. photo 16, Plate XXIV); the bulan bulan (*Megalops cyprinoides* (BROUSS.)); and the kiper, or more correctly kettang-kettang (*Scatophagus argus* C. V.). VAN KAMPEN (25) further mentions a fresh water fish, viz. the betok (*Anabas scandens* C. V.). Personally I have never come across *Anabas scandens* C. V. in the empangs. Neither had any of the natives living and working among the marine fish-ponds of Batavia, when I inquired personally or through others, ever found betok in the empangs, nor had they heard of the existence of that fish in those ponds. Neither have I any knowledge or experience proving that *Anabas scandens* C. V. should occur in brackish water outside the empangs.

Also SYBRANDI (41) says in one of his studies of Javanese aquarium fishes, that as far as he is aware, *Anabas scandens* C. V. does not occur in brackish water and that "he never came across this animal in the basket of a Javanese fishing in the rivermouths". GÜNTHER (5) furthermore mentions fresh water exclusively as the milieu of *Anabas scandens* C. V.. DAY (7) however speaks not only of "fresh water", but also of "estuaries", whilst in the latest edition of BREHM (40) it says that *Anabas scandens* C. V. also occurs in tidal rivers and consequently does not shun brackish water. Nowhere however do we find it expressly stated that it was ever definitely ascertained that water in which *Anabas scandens* C. V. was living, was brackish.

Anabas scandens C. V. seems fated to be a fish about whose biology it is difficult to agree. SYBRANDI (41) already drew attention to the fabulousness of the many stories that are current about the "climbing fish". Yet the very old tale of the *Anabas scandens* C. V. which is reported to climb branches or trees rising out of the water to chase insects, highly improbable though it appears to me and also to SYBRANDI (41) and though it was never substantiated by sufficiently accurate and closely described observations, crops up again even in KONINGSBERGER (42).

In addition to the fish already mentioned by VAN KAMPEN (25), I frequently found fairly large quantities of lundu (*Macrones gulio* (HAM. BUCH.)) in the empangs. The lundu is well known as a genuine coastal and brackish water fish. DAY (7) and also WEBER and DE BEAUFORT (38) say that *Macrones gulio* (HAM. BUCH.) occurs "in seas, estuaries and tidal rivers".

Yet this fish, at home in a milieu where the salinity may vary considerably, evidently bore the increase of the salinity in the empangs in the latter half of 1918 far less well than e.g. *Haplochilus panchax* (HAM. BUCH.), which is originally a genuine fresh water fish. As reported in Chapter IV I observed on September 24th 1918 in pond A of Map II, where the salinity had gone up to 75.6 ‰, a large number of *Macrones gulio* (HAM. BUCH.) floating about at the surface of the water, belly upwards and dying. These animals looked more or less dried out and shrivelled and were exceedingly slow in their movements. Therefore (cf. also Chapter VI) I think I may assume that this general dying of *Macrones gulio* (HAM. BUCH.) was directly connected with the just mentioned high salinity of the pond-water.

Occasionally I also found kerrong kerrong paddi (*Therapon jarbua* BLKR.) in the empangs.

I was further able to ascertain the presence in the empangs of the krapu lumpur (*Epinephelus pantherinus* BLKR.); of the buntel barih (*Tetrodon immaculatus* LAC. = *Crayracion immaculatus* BLKR.), and of a number of Gobiidae, among which were species of *Gobius*, *Periophthalmus* and *Eleotris*.

The *Periophthalmus* species, called ikan glodok, however, are still more at home in the mangrove- and *Nipa*-belt than in the empangs.

Besides the bandeng proper (*Chanos chanos* (FORSK.)) and the bandeng lelaki (*Elops hawaiensis* T. REGAN) there is yet an other fish which occurs, though not frequently, in the empangs and bears the name of bandeng, viz. the bandeng tjururut (*Albula vulpes* (L.)). Only once did a specimen of this latter fish, captured in the empangs, get in my possession.

The above enumeration may be said to include all the more commonly occurring species of fish of the empangs. It is not improbable however that if one took sufficient trouble one might ascertain the occasional occurrence of still many other species of fish there.

Many of those who have visited the Batavia empangs, will have been struck by the mostly oblong pear-shaped jelly-like masses which occur so frequently in the marine fish-ponds, where under the water the perpendicular pond margins pass into the pond bottom. These oblong pear-shaped jelly-like masses in which a large number of very fine grains can be discerned with the naked eye, and which are fixed to the pond-bottom by a likewise jelly-like but slightly more filmy hollow stalk, penetrating far into the muddy soil, are represented in figures 32a and b and fig. 33. Sometimes (cf. figure 32a and b) the stalk extremity of the jelly-like mass and the hollow stalk itself is found to contain moreover a few bunches of much bigger more or less oblong grains. Besides the stalk sometimes intrudes a little way into the jelly-like mass, as may be seen in fig. 32a and fig. 33. Fig. 32b shows the same jelly-like mass with the broken off stalk, which had been fixed in the soil, as fig. 32a; in fig. 32b however the extremity of the stalk no longer intrudes into the jelly-like mass. This intrusion and protrusion of the stalk which passes into the jelly-like body may happen when the jelly-like mass is moved by the water. The dimensions of these jelly-like bodies are seen in fig. 32a and 33 which have been drawn in natural size. In the empangs I have sometimes seen jelly-like bodies bigger and especially broader and thicker than that in

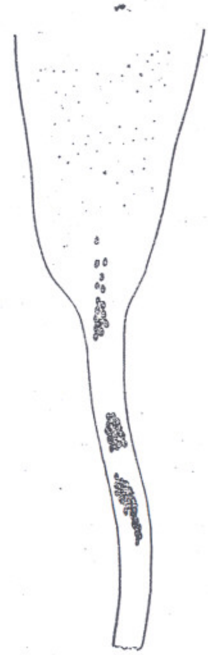
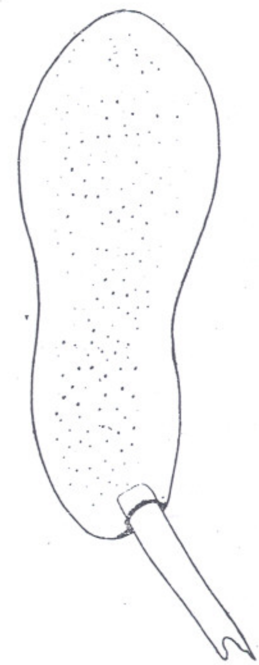


Fig. 32. Jelly-like egg-cocoons of *Eunice spec.* from the Batavia empangs. The fine grains are embryos, the bunches of bigger more or less oblong grains are faeces. × 1.



Fig, 33. Jelly-like egg-cocoon of *Eunice spec.* from the Batavia empangs. × 1.

fig. 32a. On the other hand I do not recollect seeing much smaller jelly-like bodies in the empangs than the one in fig. 33.

At Batavia the native population give these jelly-like masses the name of "kontol-ayer" [1]). If asked what those kontol-ayer are properly speaking they will unvariably reply: "telor-udang", i.e. eggs of Decapoda Macrura.

Fig. 34. Young larva of *Eunice spec.* from a jelly-like egg-cocoon collected in the Batavia empangs. × 68.

Upon investigation however I found that the kontol-ayer are the egg-cocoons of a Polychaete. Similar though considerably smaller egg-cocoons were discovered about 1850 by MAX SCHULTZE near the island of Neuwerk in the vicinity of Cuxhaven at the mouth of the river Elbe. He took them for egg-cocoons of *Arenicola piscatorum* LAM. (= *Arenicola marina* L.). Afterwards however DE GROOT ([21]) demonstrated that they belonged to *Scoloplos armiger* O. F. MüLLER.

When I first examined the contents of a kontol-ayer under the microscope, the fine grains observable in it with the naked eye, proved to be globular embryos either still practically motionless or already slowly revolving. Another cocoon contained larvae which had all arrived already at the phase of fig. 34, which evidently corresponds approximately with the *Nectochaeta*-stage of the pelagic larvae of other Polychaeta. Three days later the larvae of the egg-case from which the larva of figure 34 had been taken had reached the stage of fig. 35.

Fig. 35. Larva of *Eunice spec.* from a jelly-like egg-cocoon collected in the Batavia empangs. The larva is three days older than the larva shown in fig. 34. × 69.

The larvae move fairly rapidly through the jelly-like mass in which there swarm also a large number of Ciliates, just as DE GROOT ([21]) describes for the egg-cocoons of *Scoloplos armiger* O. F. MüLLER. In other respects as well there is clearly a good deal of similarity between the egg-cocoons of *Scoloplos armiger* and the kontol-ayer of the Batavia empangs.

Thus DE GROOT ([21]) describes the filmy crust of the jelly-bags of *Scoloplos armiger* O. F. MüLLER consisting of fine ooze and Diatoms, which in the old cocoons becomes wrinkled; this is found in exactly the same manner in the kontol-ayer, whilst also in both cases the jelly inside the crust is pellucid.

On May 28th, 1918 in pond G of Map II which contained a good deal of kontol-ayer along the margins, the

[1]) This name is not very decent. Kontol indeed is at Batavia a vulgar native word meaning the human penis.

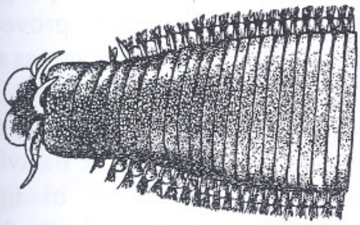


Fig. 36. Anterior part of *Eunice spec.* from the Batavia empangs seen from the dorsal side. ×4½.

workmen were engaged in deepening the pond along the east side. The mud dug up from the margin of the pond where the belt-ditch runs (cf. Chapter I) was thrown on to the dyke surrounding the pond. In this mud I found a great many red Polychaeta belonging to a species of *Eunice.*

The head-extremity of this *Eunice* species seen from the dorsal, the ventral and the dexter sides respectively, is rendered in figures 36, 37 and 38. The animals have five tentacles, which is characteristic of *Eunice* and a few other genera of Polychaete worms; the specimen from which fig. 37 was drawn deviated in having only four.

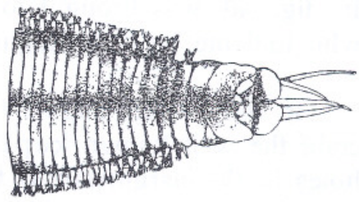


Fig. 37. Anterior part of *Eunice spec.* from the Batavia empangs seen from the ventral side. ×4.

Then fig. 39 shows us a cross-section of an *Eunice* from the empangs, hardened in formol; in this the structure of the parapodia typical of this genus of Polychaeta is visible.

That the kontol-ayer are really the egg-cocoons of this *Eunice* species I think I may infer from the following facts.

In the first place pond G of Map II on May 28th, 1918 contained a great many kontol ayer, and the mud dug away from that pond precisely from the part where the kontol-ayer occurred, that is the margins, contained a great many specimens of our *Eunice* species, but no other Polychaeta.

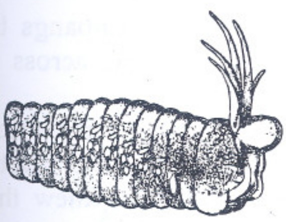


Fig. 38. Anterior part of *Eunice spec.* from the Batavia empangs seen from the right side. ×4½.

In the second place the faeces, continually dropped by the live *Eunice* individuals just taken from their milieu, were exactly similar in dimensions and composition to the more or less oblong grains, referred to above, which are generally found in the hollow stalk and sometimes also in the stalk-extremity of the jelly-like cocoon, frequently, at least as regards the stalk, in still larger quantities than are exhibited in fig. 32a and b.

From the presence of the *Eunice* faeces in the hollow stalk by which the egg-cocoon is rooted in the mud-bottom it follows in my opinion that this hollow stalk continues as a lining of the wall of the burrow in which the worm lived that laid the eggs and therewith secreted the jelly-like cocoon (cf. DE GROOT ([21]), p. 27 ff.).

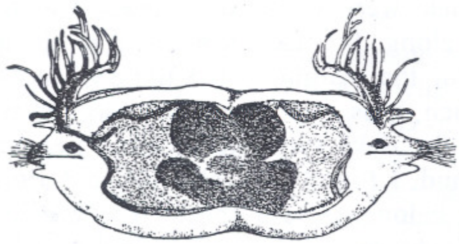


Fig. 39. Cross-section of *Eunice spec.* from the Batavia empangs. ×7½.

The stalks of the kontol-ayer taken from the Batavia empangs which I saw, accordingly proved always to have been torn across at the end away from the cocoon.

I did not personally come across any other Polychaeta in the Batavia empangs than specimens of the *Eunice* species mentioned here. As stated in Chapter VI however, I once found the fore-intestine of a number of *Haplochilus panchax* (HAM. BUCH.) caught in the empangs, filled with Nereidae. In addition the *Nereis* shown in fig. 40 was brought to me by one of my native fishermen who told me he had caught the animal in an empang.

Fig. 40. *Nereis spec.* from the Batavia empangs. Dorsal view. ×1.

In the Batavia marine fish-ponds there occurs abundantly a crab, the well known kepiting (*Portunus sp.*) which dwells in holes in the marginwalls of the ponds. VAN KAMPEN (27) (page 94) already describes how this animal is caught.

The empangs are also inhabited by a number of Decapoda Macrura whose general Malay name is "udang", and which are regularly caught and sold for consumption, at least the smaller-sized species.

I can only give a few notes on two Macrura, an *Alpheus* and a *Thalassina* species. On January 15th 1919 I received the animal belonging to an *Alpheus* species, which is shown in the life-size figures 41 and 42 (Plate XXV). The native who brought it to me said that it came from an empang near Gagah (Division (Afdeeling) Meester Cornelis, District Tjabangbungin). Also several other natives experienced in the work of the empangs to whom I showed the animal told me they had sometimes come across it in the empangs.

In the neighbourhood of Batavia the Malay name of this *Alpheus* species occurring in the empangs is udang plĕtók or udang tjĕték. Both plĕtók and tjĕték are anomatopoeical words. The natives that knew the animal told me as a matter of fact that it makes a sound that can be represented by some such combination as plĕtók or tjĕték. In the Cambridge Natural History, Volume IV (28), page 198, it is also mentioned that Alpheidae "can emit a sharp cracking sound with the larger claw".

The genus *Alpheus* comprises a great many species which are chiefly met with in tropical seas, and especially in sheets of water or pools on coral reefs. The occurrence of on *Alpheus* species in the empangs consequently seems to me to be worth mentioning. The reader may be reminded

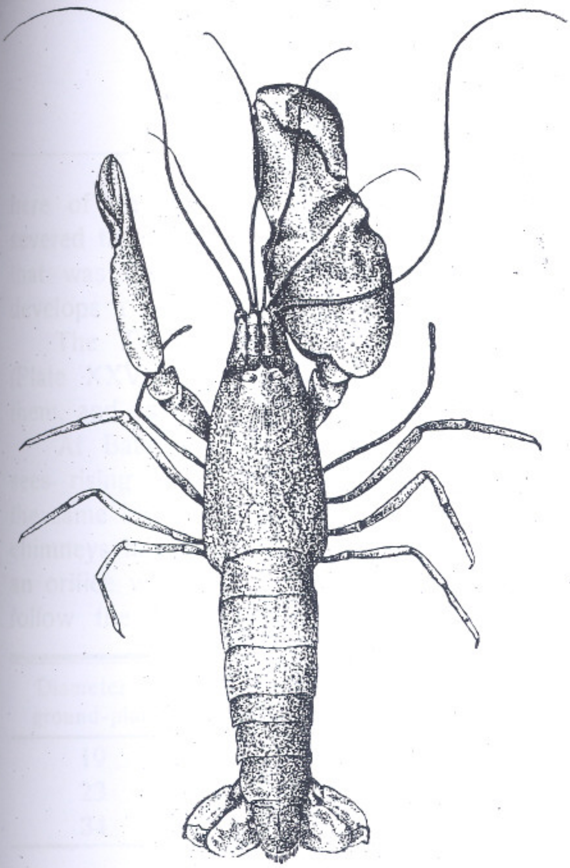


Fig. 41. Udang plĕtók or udang tjĕték (*Alpheus spec.*) from an empang near Gagah. Dorsal view. × 1.

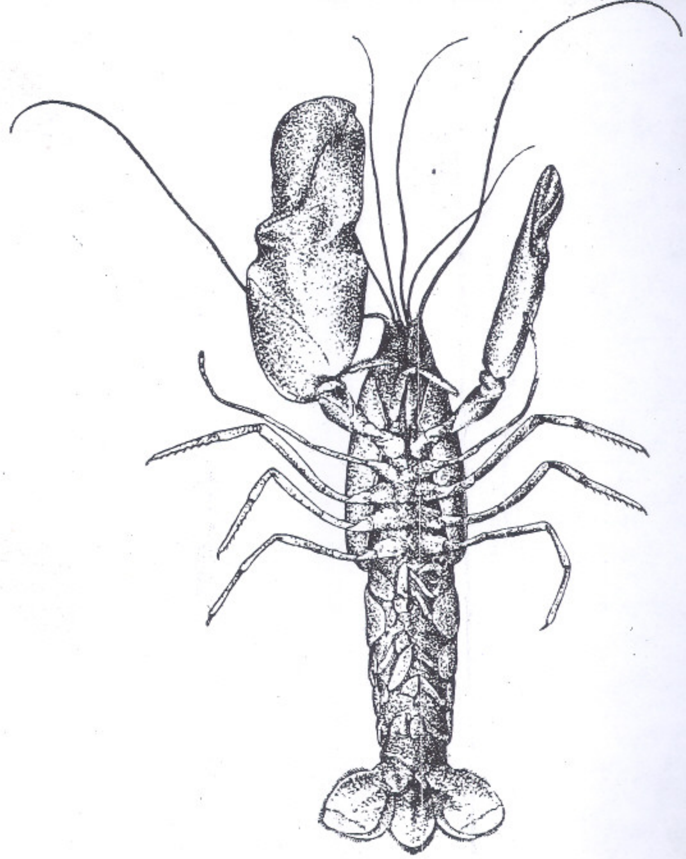


Fig. 42. Udang plĕtók or udang tjĕték (*Alpheus spec.*) from an empang near Gagah. Ventral view. × 1.

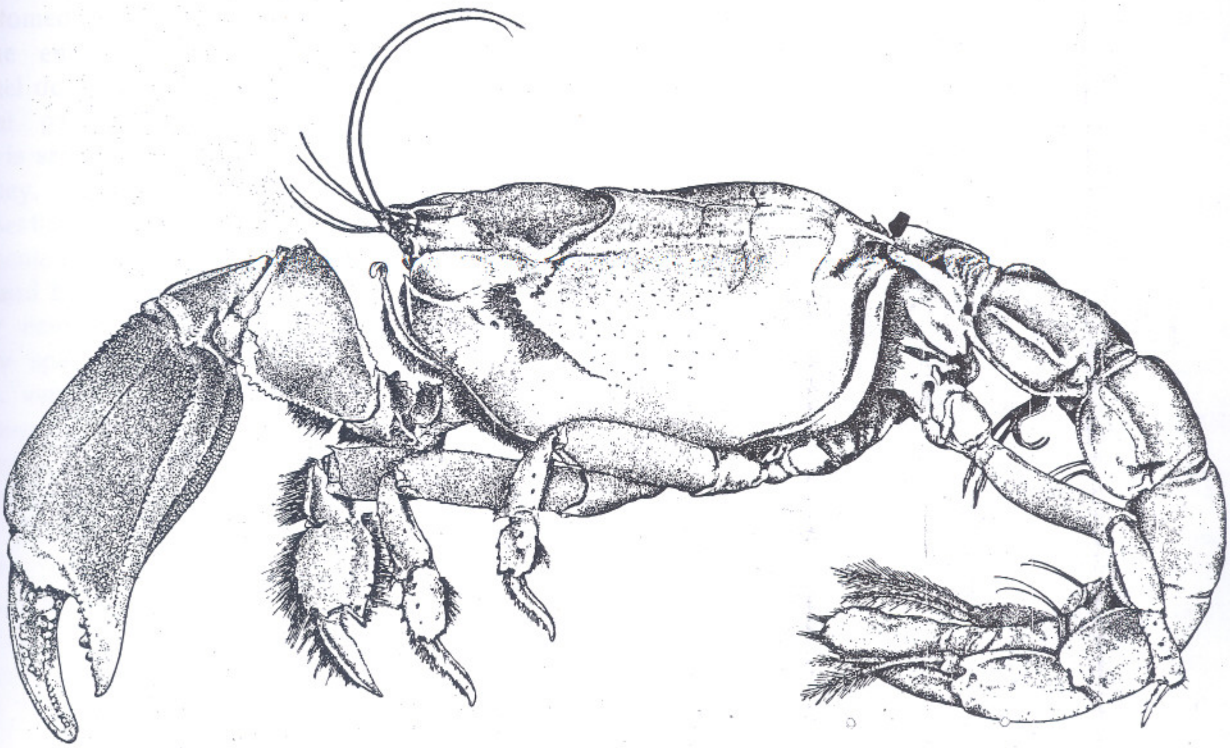
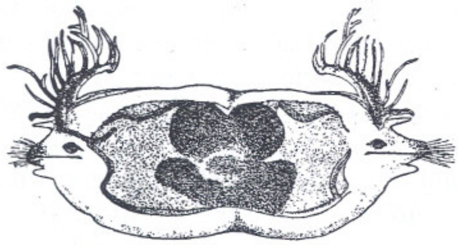


Fig. 43. Udang tanah (*Thalassina spec.*) from between the empangs near Luar Batang (cf. Map II). Seen from the left side. × 1.



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In the Batavia marine fish-ponds there occurs abundantly a crab, the well known kepiting (*Portunus sp.*) which dwells in holes in the marginwalls of the ponds. VAN KAMPEN ([27]) (page 94) already describes how this animal is caught.

The empangs are also inhabited by a number of Decapoda Macrura whose general Malay name is "udang", and which are regularly caught and sold for consumption, at least the smaller-sized species.

I can only give a few notes on two Macrura, an *Alpheus* and a *Thalassina* species. On January 15th 1919 I received the animal belonging to an *Alpheus* species, which is shown in the life-size figures 41 and 42 (Plate XXV). The native who brought it to me said that it came from an empang near Gagah (Division (Afdeeling) Meester Cornelis, District Tjabangbungin). Also several other natives experienced in the work of the empangs to whom I showed the animal told me they had sometimes come across it in the empangs.

In the neighbourhood of Batavia the Malay name of this *Alpheus* species occurring in the empangs is udang plĕtók or udang tjĕték. Both plĕtók and tjĕték are anomatopoeical words. The natives that knew the animal told me as a matter of fact that it makes a sound that can be represented by some such combination as plĕtók or tjĕték. In the Cambridge Natural History, Volume IV ([28]), page 198, it is also mentioned that Alpheidae "can emit a sharp cracking sound with the larger claw".

The genus *Alpheus* comprises a great many species which are chiefly, met with in tropical seas, and especially in sheets of water or pools on coral reefs. The occurrence of on *Alpheus* species in the empangs consequently seems to me to be worth mentioning. The reader may be reminded here of the regeneratio inversa observed in *Alpheus*. If the larger claw is severed the smaller claw develops into the inverse image of the larger claw that was lost, whilst in the place where the lost one had been there develops a new claw which is the inverse image of the original smaller claw.

The *Thalassina* species mentioned above, and represented in fig. 43 (Plate XXV), occurs properly speaking, not in the empangs, but between them, and as a matter of fact in the walls separating the ponds.

At Batavia and especially between the empangs of Luar Batang, one sees rising above those walls here and there little chimneys consisting of the same kind of soil of which the walls themselves are composed. These chimneys have the shape of low truncated cones whose top plane exhibits an orifice which is not purely circular but somewhat oval shaped. Below follow the dimensions in centimetres of three of these little chimneys.

Diameter of ground-plane	Height	Diameter of top plane	Diameters of the oval aperture in the top plane
19	10	12	2.3—2.5
23	12	14	4.5—5
34	15	17	5 —6

From these chimneys a channel leads down into the ground. The natives who are accustomed to work and dig in the empangs say that this channel down below divides into several galleries and each of these is said to lead to a separate chimney. Now it is in these galleries that the *Thalassina* species represented in fig. 43 (Plate XXV) lives and burrows; at Batavia its Malay name is udang tanah. A few specimens of this udang tanah venturing out of their chimneys were captured by my fishermen.

It appears that the galleries never debouch in the empangs. Neither did I, nor any of the natives who are at home in the empangs and of whom I enquired, ever find a *Thalassina* in the ponds themselves.

Fig. 44. Gammarid occurring regularly and numerously among the algal masses and higher submerged aquatic plants in the Batavia empangs. × 16.

It therefore seems that the udang tanah lives exclusively in the ground, in galleries that reach down into the ground-water. Hence this animal and its chimneys may be met with at a fairly long distance away from the water's edge. Thus my amanuensis, Mr. E. C. A. HERBST, found the chimneys of udang tanah at some tens of metres from the water's edge at Bagan Si Api Api (East-coast of Sumatra, at the mouth of the Rokkan River). From Bagan Si Api Api I received a few specimens of the udang tanah that were in every respect similar to those drawn from the Batavia empang region.

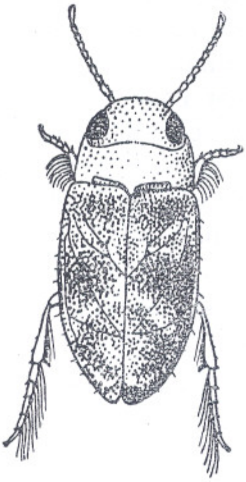

Fig. 45. Small, brown Hydroporine beetle occurring regularly among the algal masses and higher submerged aquatic plants in the Batavia empangs. Dorsal view. $\times 21^1/_2$.

It seems to have been noticed before that *Thalassina* thus lives in the ground. In "A Treatise on Zoology", edited by Sir RAY LANKESTER, Part VII ([22]), page 304, one reads: " . . . . . some Crayfishes are "found burrowing in the earth "far from streams or ponds, their "burrows reaching down to the "ground-water. The same is re-"ported of the marine or brack-"ish water *Thalassina*".

Fig. 46. Small, brown Hydroporine beetle occurring regularly among the algal masses and higher submerged aquatic plants in the Batavia empangs. Ventral view. $\times 21^1/_2$.

A Cerithiid (Prosobranchiata Monotocardia) belonging to the genus *Potamides*, subgenus *Telescopium*, is very abundant in the Batavia empangs. The flesh of this snail known at Batavia by the Malay name of b e l-e n t j o n g, is used as food by the natives. The empty belentjong shells often serve as dwellings for Paguridae.

I will now add a few more notes on certain animals occurring generally in the empangs among the conglomerates of submerged aquatic plants floating at or reaching up to just beneath the surface of the water and consisting chiefly of *Chaetomorpha*, as described in Chapter IV and illustrated in our photos 2, 3, 4, 6, 8, 9, 14 and 15 (Plate VII, VIII, IX, XI, XIV, XV, XXII and XXIII).

Fig. 47. Copepod occurring among the algal masses and higher submerged aquatic plants in the Batavia empangs. Seen from the left side, $\times 34$.

Rinsing a quantity of *Chaetomorpha* from the empangs with pond water, and then straining this pond water through plankton gauze, an impression will be gained of the fauna contained within the masses of waterplants in question.

It will then appear regularly that besides mosquito larvae (cf. Chapter VII) there always occur in the algal masses of the Batavia empangs a great many representatives of a certain Amphipod belonging to the Gammaridea, represented in figure 44; a number of small brown Hydroporines (fig. 45 and 46); many Copopods (fig. 47 and 48); a fairly large number of Ostracods (fig. 49); some Cladocera (fig. 50) and sometimes more, sometimes fewer small shell-bearing Gastropods.

Fig. 48. Copepod with five epiplanktonically living specimens of *Cothurnia*, collected in the Batavia empangs among the submerged vegetation. Seen from the left side. × 35.

The Gammaridea kept in small aquaria at my laboratory built little dwelling tubes from all sorts of vegetable materials. When there was no other material within reach the little tubes were built with *Chaetomorpha* threads.

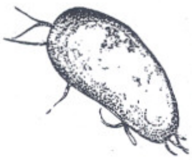

Fig. 49. Ostracod occurring among the algal masses and higher submerged aquatic plants in the Batavia empangs, seen from the left side. ×26.

In the Cladocer of fig. 50 the brood-pouch is clearly visible at the dorsal side within the bivalve shell.

On the dorsal side of the abdominal segments of the Copepod of fig. 48 five specimens of *Cothurnia* (Ciliata, Peritrichida) have fixed themselves. I also found *Cothurnia* at the empangs attached to *Chaetomorpha*-threads, likewise *Vorticella* (Ciliata, Peritrichida) and especially also *Folliculina* (Ciliata, Heterotrichida).

Fig. 50. Cladocer occurring among the algal masses and higher submerged aquatic plants in the Batavia empangs, seen from the dexter side. × 31½.

The aquatic Hemipteron, represented in fig. 51 and 52, and belonging to the genus *Sphaerodema* (family Belostomatidae) I frequently came across in the algal masses of the Batavia empangs. The *Sphaerodema* females, it is well known, fix their eggs on the backs of their males. Fig. 51 shows us a *Sphaerodema* male thus burdened with eggs, which I captured in an empang.

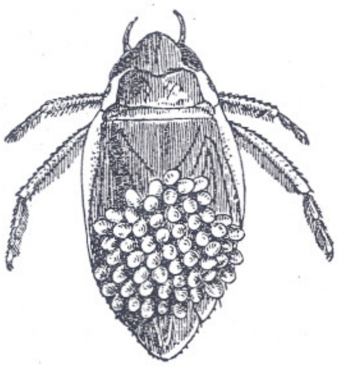

Fig. 51. Male of *Sphaerodema spec.* carrying eggs. Dorsal view. From among the submerged vegetation of the Batavia empangs. × 2¾.

I also found at the Batavia empangs larvae of Odonata Anisoptera. I mention this especially because these larvae, represented in figures 53 and 54 were living on February 23rd 1920 in water possessing a salinity of 20.1 ‰. Before that, viz. on April 29th 1919, I had also come across a great number of larvae of Odonata Anisoptera in a shallow piece of water on Verlaten-Eiland (= Deserted Island, in the Krakatau group), this water having at that moment a salinity of 22,5 ‰.

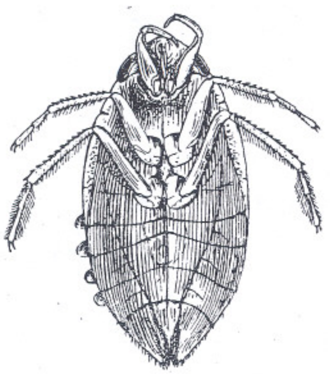

Fig. 52. Male of *Sphaerodema spec.* carrying eggs. Ventral view. From among the submerged vegetation of the Batavia empangs. × $2^3/_4$.

In small aquaria with water from the marine fish ponds in which were put exclusively plants and animals collected from the empangs, I frequently saw pretty Nudibranchs, one of which is represented in figures 55 and 56, moving along the glass wall or creeping among the *Chaetomorpha* threads.

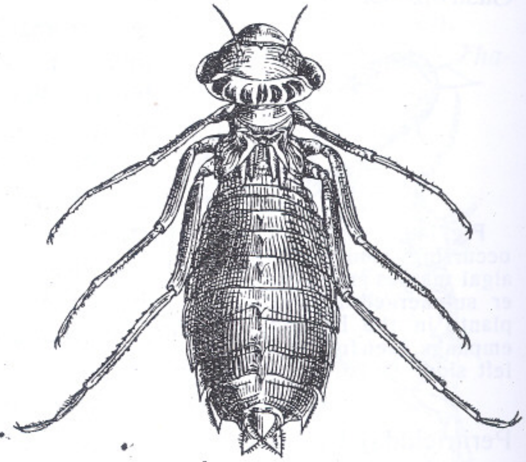

Fig. 53. Larva of an Anisopterous Odonate from the Batavia empangs living in water whose salinity amounted to 20.1 $^0/_{00}$. Dorsal view. × $5^1/_2$.

The Hexactinid of fig. 57 was also discovered by us in an aquarium of this kind. When I had the animal drawn the draftsman the first day got as far as a general sketch in pencil and finishing the 36 tentacles in ink. The animal was then put back into the aquarium. The next day however it was not found again and in fact it was never seen again after that. Owing to its disappearance I could not examine its interior so that I am not in a position to say for certain to which group of the Hexactinidae the animal ought to be reckoned. Outwardly however it strongly recalled the Halcampina.

Fig. 54. Larva of an Anisopterous Odonate from the Batavia empangs living in water whose salinity amounted to 20.1 $^0/_{00}$. Ventral view. × $5^1/_2$.

In conclusion the figures 58 and 59 represent a little animal that I picked up in an empang, but as a matter of fact in an empang that de-

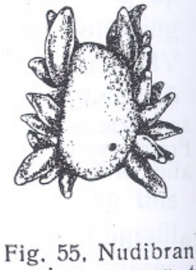

Fig. 55. Nudibranch occurring among the submerged vegetation in the Batavia empangs. Dorsal view. × $8^1/_2$.

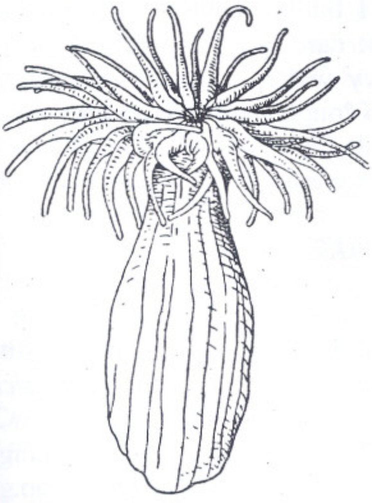

Fig. 57. Hexactinid (belonging to the Halcampina?) from the Batavia empangs. $\times 4$.

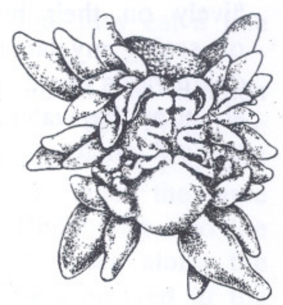

Fig. 56. Nudibranch occurring among the submerged vegetation in the Batavia empangs. Ventral view. $\times 12^1/_2$.

viated very considerably from the Batavia empangs dealt with in this publication. For this animal I found in a temporary sea fish-pond dug amidst the Rhizophores by the population of the coral-island Amsterdam (Pulu Untung Djawa), situated just north of the western extremity of the Bay of Batavia.

I found the little animal here on the 20th of November 1918, at a salinity of 35.9 $^0/_{00}$, and afterwards on May 15th 1919 at a salinity of 25.1 $^0/_{00}$. As it appears from an article by NOWROJEE (34), we are dealing here with the larva of a *Scirtes* species (family Dascillidae, Polymorpha, Coleoptera). NOWROJEE (34) says about his larvae of *Scirtes grandis* MOTS.: "they are "much lighter than "water and cannot "remain under the "surface without "clinging to some "support, and when "forced to let go "their hold they "quickly rise to the "surface. Occasion- "ally they float pass-

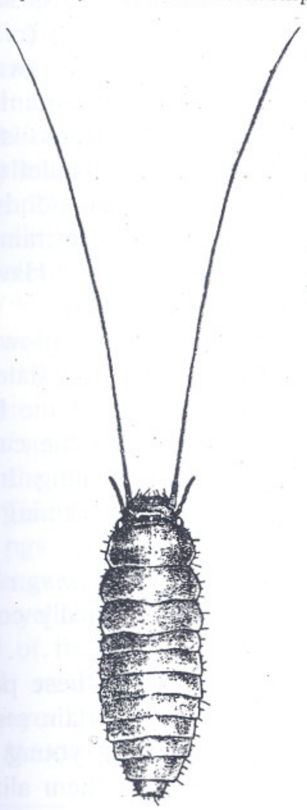

Fig. 58. Larva of *Scirtes spec.* from a fish-pond dug amidst the Rhizophores by the population of the coral-island Amsterdam. Salinity of the pond water 35.9‰ Dorsal view. $\times 7^1/_2$.

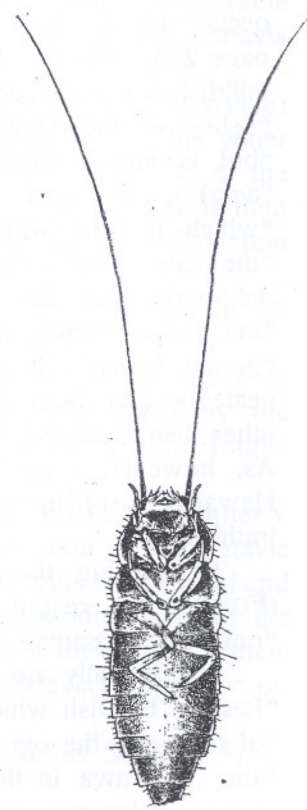

Fig. 59. Larva of *Scirtes spec.* from a fish-pond dug amidst the Rhizophores by the population of the coral-island Amsterdam. Salinity of the pond water 35.9 $^0/_{00}$. Ventral view. $\times 7^1/_2$.

"ively on their backs at the surface". I think I have a clear recollection of seeing my larvae of the island Amsterdam quite capable of swimming downwards even in the salt, i.e. heavy water, and of their not drifting about at the water-surface when they no longer had anything under water to hold on to.

APPENDIX TO CHAPTER V.

After Chapter V had been printed I found that I had forgotten to allude in it to some publications containing data concerning *Chanos chanos* (FORSK.) reared in ponds.

Thus JORDAN and EVERMANN ([18 Aa]) mention a singular-looking specimen of *Chanos chanos* (FORSK.), extraordinarily short and deep. Their description shows that they are alluding to the same kind of deviation as described by me in Chapter V (pg. 199 and 200) which is said to occur also in Australian specimens of *Chanos chanos* (FORSK.) (cf. note page 200). Further JORDAN and EVERMANN ([18 Aa]) write: "The awa" (or milkfish = *Chanos chanos* (FORSK.)) "is one of the most important food "fishes of the Hawaiian Islands. It occurs about the various islands, "but is most abundant about Honolulu. It is, next to the mullet (Ama-"ama) [1]), the most common species frequenting the artificial ponds into "which it runs with the mullet and with the tide and is restrained in "the same way". COBB ([18 Ab]) also states that the fish enter the Hawaiian sea-ponds with the current. In discussing these ponds he says: "When "the tide is coming in both doors are opened and the fish are allowed to "go in freely". In Chapters V and VIII on the other hand, I stated repeatedly that both the bandeng in the Batavia empangs, and the fry of other fish entering these ponds from the sea, swim against the current. As, however, I am ignorant of the local conditions prevailing in the Hawaiian sea-fishponds, I cannot attempt to discuss this seeming contradiction.

Concerning the Hawaiian marine fishponds in which *Chanos chanos* (FORSK.) are reared, COBB ([18 Ab]) adds: "The sea-ponds usually contain "only the ama-ama, or mullet, and the awa. . . . .
. . "Practically no attempt at fish-culture is made with these ponds. "Besides the fish which come in through the open gates at certain seasons "of the year, the owner usually has men engaged in catching young ama-"ama and awa in the open sea and bays, and transporting them alive to "these enclosures, where they are kept until they attain a marketable "size, and longer, frequently, if the prices quoted in the market are "not satisfactory. It costs almost nothing to keep them, as they find

[1]) *Mugil cephalus* L..

"their own food in the sea ponds. It is supposed that they eat a fine "moss which is quite common there".

It appears from ALVIN SEALE's (21 A) statements about the milkfish in his well-known article: "The Fishery resources of the Philippine Islands" (pg. 519–521 incl.) that the rearing of *Chanos chanos* (FORSK.) at Malabon and other places near Manila is carried on in much the same way as at Batavia and other places in Java. In the Philippines also the young of *Chanos chanos* (FORSK.) are captured in the sea along the beaches and placed in earthen jars full of water to be conveyed to the fish ponds, frequently a hundred miles distant. Thirty-three percent of those young should reach marketable size (cf. our page 223).

ALVIN SEALE (21 A) also mentions the swimming against the current of *Chanos chanos* (FORSK.), reared in fish-ponds.

Further he says that the milkfish is particularly adapted to pond-culture, being a vegetable feeder of rapid growth. According to ALVIN SEALE (21 A) the food of the awa in the Philippine sea-ponds consists of *Oedogonium* [1]) (Chlorophyceae, Ulotrichales) i. e. a green filamentous alga comparable with the *Chaetomorpha* on which the bandeng feeds in the Batavia empangs.

I further quote the following passages from SEALE's (21 A) article: "If it is desired to cultivate the food alga" (scil. *Oedogonium*) "the water "is allowed to drain off and the clay is exposed to the full power of the "sun. The alga rapidly makes its appearance and a little water is then "permitted to cover the bottom. This is gradually increased as the *Oedogonium* "develops . . . .

. . "The *Oedogonium* is sometimes purchased and placed in an "exhausted pond" (cf. our pages 211 and 213). . . . .

. . "When the fry are to be planted in the pond, the water is "again allowed to drain off and the alga is partially killed by the "hot sun. This, it is claimed, renders the *Oedogonium* soft and fragile "for the tiny mouths."

This latter passage reminds us of the fact, mentioned in my Chapter V (cf. pgs. 211 and 218) that the *Chaetomorpha*-vegetation of the Batavia empangs is not at its best as bandeng-food until it begins to grow old and turn yellow. ALVIN SEALE (21 A) however is not speaking here of the food of the larger *Chanos chanos* (FORSK). but of that of the awa-fry, which, as I mentioned in Chapter V, feeds in the Batavia empangs on "tay-ayer".

MAXWELL (64) only quotes some passages from ALVIN SEALE (21 A).

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1) According to ENGLER and PRANTL (13) *Oedogonium* occurs in fresh and slightly brackish water. It would be interesting to know in this connection which is the salinity of the water in the Philippine sea-ponds and whether SEALE's (21 A) determination is correct. The question also arises, whether *Chaetomorpha* does not occur also in the Philippine marine fish-ponds.

In conclusion I may mention that I found in The National Geographic Magazine, Washington D. C., a photo by Mrs. ROSAMOND DODSON RHONE (65), showing "a social leader of Nauru in costume for the celebrated fish dance". The fish with which the lady has adorned her person, may be easily recognized as *Chanos chanos* (FORSK.). Which gives rise to the question, whether marine fishponds in which *Chanos chanos* (FORSK.) are reared, are not found also at Nauru or Pleasant Island.

TABLES.

The local names occurring in the Tables refer to that part of the marine fish-pond belt of Batavia in which the ponds in question are situated. All those names are to be found on Map I.

Consecutively from West to East the parts of the Batavia marine fish-pond belt, situated between the Muara Angke and Slingerland or Oesterbank, bear the following names:

Muara Karang,
Fluit (Djembatan Tomes),
(Muara) Pegantungan,
Pekulitan,
Luar Batang,
Jaagpad,
Heemraad,
Heemraad Oost,
Antjol.

LIST OF TABLES.

TABLE IV. (Observation-table). Combined data concerning the salinity of the pond-water, the production of Anophelines and the composition of the submerged vegetation, collected in the Batavia sea fish ponds.

TABLE V. Salinities and quantitative data concerning the production of Anophelines, collected in the Batavia marine fish ponds in 1918 and 1919 and arranged topographically and in the order of the salinities; with for each 10 ‰ (or 5 ‰) of the salinity the average of the mosquito-net catches per 10 M^2 and per night and the total of the Anopheline ♀♀ emerged from the larvae and pupae collected.

TABLE VI. Topographically and chronologically arranged data concerning salinities and Anophelines, collected in the Batavia sea fish ponds in 1918 and 1919; with monthly averages of the salinities and of the mosquito-net catches per 10 M^2 and per night and monthly totals of the Anopheline ♀♀ emerged from the larvae and pupae collected.

TABLE VII. A. Average number of ♀♀ of *Myzomyia ludlowi* THEOBALD captured by means of mosquito-nets per 10 M^2 and per night at different salinities.

B. Average number of ♀♀ of *Myzomyia rossii* GILES captured by means of mosquito-nets per 10 M^2 and per night at different salinities.

TABLE VIII. Monthly averages of the numbers of ♀♀ of *Myzomyia ludlowi* THEOBALD and of *Myzomyia rossii* GILES captured by means of mosquito-nets per 10 M^2 and per night.

TABEL IX. Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ♀♀ of *Myzomyia rossii* GILES at different salinities. Mosquito-net catches and imagines emerged from larvae and pupae collected.

TABLE X. Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ♀♀ of *Myzomyia rossii* GILES in different months. Mosquito-net catches and imagines emerged from larvae and pupae collected.

TABLE XI. Averages and other resultant figures concerning salinities and Anophelines, derived from the Tables VII A, VII B and IX and relating to the entire Batavia empang zone.

TABLE I.

Chronologically and topographically arranged salinities (S $^0/_{00}$) which were observed in 1918 and 1919 in the pond-system of Mr. Max H. Th. Görs, situated near Muara Karang and represented in Map II.

Date.	Pond A of Map II at 1. L.	Pond B of Map II at 2. L.	Fry-ponds C of Map II at 3. M.	New fry-ponds C′ of Map II at 3a. M.	Pond D of Map II at 4. M.	Pond E of Map II at 5. z.	Pond F of Map II at 6. Z.	Pond G of Map II at 7. z.	Pond G of Map II at 7a. M.
5 III '18			nearly fresh [1]) water.				5.5	nearly fresh [1]).	
19 „ „	6.2 and 5.7	6.3 and 6.5	7.5	—	7.9	—	25.8	6.8	—
3 IV „	12.4	10.8 and 9.3	12.1	—	12.9	—	25.9	14.3	7.5
16 „ „	10.9	13.1	18.1	—	16.8	—	—	24.7	16.7
27 „ „	15.1	13.0	17.3	—	17.2	19.2	24.6	23.6	—
14 V „	14.4 and 21.1	16.7	20.35	—	21.4	—	23.1	21.4	—
28 „ „	15.1	19.1	19.1	—	20.7	24.0 and 21.3	21.1	20.1	—
15 VI „	21.0 and 24.6	25.2	30.2	—	24.9	28.3	24.7	26.4	—
27 „ „	26.4	30.4	34.0; 38.1 and 40.2	—	29.4	—	25.6	27.8	—
16 VII „	36.6	35.0 and 40.2	47.8 and 50.0	—	—	36.5	28.35	31.7	—
20 „ „	—	—	47.0	—	—	—	—	—	—
30 „ „	—	41.55	42.4	—	32.95	34.4	25.95	29.3	35.2
6 IX „	53.4	—	57.9	—	—	—	30.4	31.7	—
24 „ „	75.6	73.6	56.9 and 52.2	—	—	46.2	34.2	42.4	—
15 X „	56.2	58.4	—	62.8	72.4	—	36.5	45.8	—
28 „ „	76.6	62.1	60.5	77.6	75.1	50.2	38.4	48.3	—
18 XI „	60.6	53.5	64.9	56.3	65.4	—	33.2	39.3	—
14 XII „	53.8	44.9	53.5	—	45.0	44.6	31.1	42.7	—
10 II '19	26.5	22.0	22.9	—	21.5	19.8	16.8	21.8	—
17 IV „	18.1	15.6	19.3	19.6 and 20.6	19.8	—	22.6	21.5	18.3
2 VII „	15.0	13.6	18.8 and 16.7	—	17.5	—	21.1	17.4	13.3
12 VIII „	28.2	26.7	37.7	35.9	29.4	—	27.6	27.6	—
20 X „	63.3	56.5	81.0	—	73.4	43.6	34.2	50.8	—
4 XI „	68.4	55.7	93.2	65.7	74.5	49.7	42.9	49.2	46.5

[1]) that means of a salinity below 3.5 $^0/_{00}$.

TABLE II.

Chronologically and topographically arranged salinities whic sions to various sea fish-ponds situated between Kamal and Tjil

EAST <———

	1a	1b	(2)	(3)	4	5	6	7	8a
15 III '18	—	—	—	—	—	—	—	—	—
19 „ „	—	—	—	—	—	—	—	—	—
3 IV „	—	—	—	—	—	—	—	—	—
16 „ „	—	—	—	—	—	—	—	—	—
14 V „	—	—	—	—	—	—	—	—	26.4
29 VI „	—	—	—	—	—	—	—	—	—
2 VII „	21.6; 21.5	25.3; 26.5	—	—	—	—	—	—	—
16 „ „	—	—	—	—	—	—	—	—	—
25 „ „	—	—	—	—	—	—	—	—	—
6 IX „	—	—	—	—	—	—	—	—	—
15 X „	—	—	—	—	—	—	—	—	—
22 „ „	—	—	—	—	—	—	—	11.5;13.5;15.4	—
28 „ „	—	—	(33.0)	(34.3)	45.2	35.85	33.0	—	—
8 XI „	—	—	—	—	—	—	—	—	—
18 „ „	—	—	—	—	—	—	—	—	—
24 XII „	—	—	—	—	—	—	—	20.2	—

1 = fish-ponds of Tjilintjing. *a.* landward ponds.
b. seaward ponds.

2 = deserted ponds in open communication with the sea, situated east of and quite near Slingerland.

3 = *Nipa*-swamp south of Slingerland.

4 = ponds at the southern entrance of the Slingerlandsche Weg.

5 = ponds south of Kampong Antjol.

6 = pond situated between Antjol and the mouth of the Gunung Sahari canal.

7 = ponds of Heemraad Oost.

8 = ponds of Heemraad. *a.* pond situated most eastward.
b. pond situated between pond a and pond c.
c. pond situated most westward.
d. small pond situated south of pond c.

-mined, between the regular observations, on a number of excur-
Map I).

⟶ WEST.

	8d	9a land-side	9b ◄—	9c —►	9d sea side	9e	10	11a land-side	11b ◄—►	11c sea-side	12
3	3.4	—	—	—	—	15.5;21.05	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	27.6	—
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	29.8	33.8	34.05	—
	—	—	—	—	—	—	—	—	—	—	35.95
	—	—	—	—	—	—	—	43.8	43.8	43.8	—
	—	—	—	—	—	—	36.2	—	—	58.2	—
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—
	—	46.5	45.5	51.8	55.0	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	45.9	—
	—	—	—	—	—	—	—	—	—	—	—

=ponds of Jaagpad. *a.* most landward pond.
b. pond situated seawards of pond a.
c. pond situated seawards of pond b.
d. most seaward pond.
e. pond situated west of the ponds a, b, c and d.

=ponds of Luar Batang.

=ponds of Ang Sun Hian, situated near Kampong Fluit.
a. small pond situated most landward.
b. large pond situated seawards of pond a.
c. pond situated seawards of pond b, about halfway between the land and sea boundaries of the pond-system.

=ponds of Kamal.

TABLE III.

Data concerning salinities and Anophelines collected in 1917 in the Batavia sea fish ponds by Dr. B. C. P. JANSEN and Mr. M. L. VAN BREEMEN.

Date	Place	Salinity S ‰	Imagines emerged from larvae and pupae collected	
			Myzomyia ludlowi Theobald	Myzomyia rossii Giles
23 X '17	Heemraad	11.5	10	18
" " "	"	13		
" " "	"	13.5		
" " "	"	13		
24 X '17	"	15	27	28
" " "	"	17		
" " "	"	17		
" " "	"	12		
25 X '17	"	14	15	25
" " "	"	13		
" " "	"	13		
" " "	"	14		
29 X '17	"	13	27	23
" " "	"	12		
" " "	"	13		
" " "	"	15		
1 XI '17	"	13	43	8
" " "	"	13		
" " "	"	12.5		
" " "	"	12.5		
2 XI '17	Antjol	11	35	13
" " "	"	16.5		
" " "	"	12		
" " "	"	14.5		
3 XI '17	"	12	21	10
" " "	"	13		
" " "	"	15.5		
" " "	"	14.5		

Date	Place	Salinity S $^0/_{00}$	Imagines emerged from larvae and pupae collected	
			Myzomyia ludlowi Theobald	Myzomyia rossii Giles
5 XI '17	Antjol	15	22	7
„ „ „	„	17		
„ „ „	„	16		
„ „ „	„	13.5		
15 XI '17	Luar Batang	14	9	25
„ „ „	„	23		
„ „ „	„	28		
„ „ „	„	27		
16 XI '17	„	27	2	5
„ „ „	„	31.5		
„ „ „	„	31		
„ „ „	„	31		
17 XI '17	„	32.5	0	3
„ „ „	„	31.5		
„ „ „	„	32.5		
„ „ „	„	31.5		
19 XI '17	Pekulitan	19.5	11	31
„ „ „	„	21		
„ „ „	„	24		
20 XI '17	Fluit (Djembatan Tomes)	22	19	22
„ „ „	„	14		
„ „ „	„	24		
„ „ „	„	27		
21 XI '17	„	17	0	13
„ „ „	„	18		
22 XI '17	Muara Karang	29	4	50
„ „ „	„	30.5		
„ „ „	„	12		
„ „ „	„	25		

Date	Place	Salinity S $^0/_{00}$	Imagines emerged from larvae and pupae collected	
			Myzomyia ludlowi Theobald	Myzomyia rossii Giles
29 XI '17 " " "	Muara Angke "	25 26	1	14
1 XII '17 " " " " " " " " "	Jaagpad " " "	22 26 19.5 19	5	16
3 XII '17 " " "	" "	17 27	15	41
4 XII '17 " " " " " "	" " "	16 13 22	11	12
6 XII '17	"	10.5	1	21
1 XII '17 " " "	Antjol "	31.5 31.5	0	4
3 XII '17 " " "	" "	32.5 31.5	1	24
5 XII '17 " " "	" "	13 23	1	12
7 XII '17 " " "	" "	19.5 14	0	22
8 XII '17	"	5.5	0	3
6 XII '17 " " "	Heemraad. "	17.5 15	2	8
7 XII '17 " " "	" "	6.5 11	9	8

Date	Place	Salinity S ‰	Imagines emerged from larvae and pupae collected	
			Myzomyia ludlowi Theobald	Myzomyia rossii Giles
8 XII '17	Heemraad	17		
" " "	"	19.5	13	15
" " "	"	19.5		
11 XII '17	"	15	0	22
" " "	"	16		
12 XII '17	"	18.5		
" " "	"	22	0	27
" " "	"	17		

TABLE IV. (Observation-table).

Combined data concerning the salinity of the pond-water,
tation, collected in the Batavia sea fish ponds.

Date	Place	Salinity of the pond-water $S\,^0/_{00}$	Mosquito-net catches			Imagines emerged larvae and pupa collected	
			Number of mosquito-nets	Number of ♀♀ of Myzomyia ludlowi Theobald	Number of ♀♀ of Myzomyia rossii Giles	Number of ♀♀ of Myzomyia ludlowi Theobald	Num of ♀♀ Myz my ross Gil
11 XI '18	Heemraad Oost . .	13.25	—	—	—	80	81
„ „ „	Luar Batang. . . .	29.2	—	—	—	8	2
12 „ „	„	27.8	—	—	—	8	7
„ „ „	Heemraad Oost . .	10.8	—	—	—	13	7
13 „ „	„ . . .	35,3	—	—	—	0	2
„ „ „	„ . . .	13.1	6	100	125	41	7
„ „ „	„ . . .	13.0	?	17	43	—	—
14 „ „	„ . . .	40.7	—	—	—	0	3
15 „ „	Muara Karang . . .	62.6	—	—	—	0	15
„ „ „	Heemraad Oost . .	25.0	4	35	6915	7	121
16 „ „	Jaagpad	52.5	?	0	138	—	—
„ „ „	Muara Karang . . .	45.9	—	—	—	0	92
17 „ „	Jaagpad	65.1	?	0	99	—	—
18 „ „	Muara Karang . . .	59.6	—	—	—	0	15
„ „ „	Antjol	44.0	—	—	—	0	74
19 „ „	Jaagpad	47.0	—	—	—	0	40
„ „ „	„	36.6	?	0	110	—	—
20 „ „	„	60.1	?	0	349	—	—
„ „ „	Muara Karang . . .	42.2	—	—	—	0	10
21 „ „	Jaagpad	58.7	?	0	438	0	87

luction of Anophelines and the composition of the submerged vege-

nposition of the samples of the submerged vegetation collected in the places where
ıe mosquito-nets had been set and/or the larvae and pupae had been caught.
Further data concerning the observation-places.

Date			Place	S ‰	Mosquito-net catches			Emerged from and pupae c[...]	
					Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	N[...] ros[...]
22	XI	'18	Muara Karang . . .	58.9	—	—	—	0	
„	„	„	Jaagpad	60.1	6	0	405	0	
23	„	„	Muara Karang . . .	58.4	—	—	—	0	
„	„	„	Jaagpad	54.6	6	0	189	0	
24	„	„	„	59.2	5	0	733	—	
25	„	„	Muara Karang . . .	57.8	—	—	—	0	
„	„	„	„ . . .	43.6	—	—	—	0	
„	„	„	Jaagpad	48.5	6	0	323	0	
26	„	„	Pekulitan	39.3	3	0	44	0	
„	„	„	Jaagpad	30.8	6	0	44	2	
27	„	„	Pekulitan	39.2	3	0	41	0	
„	„	„	Jaagpad	31.1	4	0	75	0	1
28	„	„	Pekulitan	39.3	10	0	219	0	1
„	„	„	Jaagpad	32.0	6	4	295	3	1
29	„	„	Pekulitan	40.0	10	1	784	0	1
„	„	„	Jaagpad	33.2	9	8	652	3	1
30	„	„	Pekulitan	36.2	10	4	214	0	1
„	„	„	Jaagpad	31.5	3	0	5	—	-
1	XII	„	Pekulitan	48.2	2	0	99	—	-
„	„	„	Heemraad Oost . .	27.2	10	6	345	—	-
2	„	„	Pekulitan	47.6	10	0	176	0	[illegible]
„	„	„	Heemraad Oost . .	26.05	10	0	178	2	1

Submerged vegetation etc.

:omorpha partly turned yellow, and filamentous Schizophyceae with sheaths (Lyngbya?); Chaetomorha-filaments thickly coated with Chamaesiphonaceae, Chlamydobacteriaceae, Diatoms, Bryozoa etc..

y Chaetomorpha cell-walls coated with Chamaesiphonaceae etc.; algal masses chiefly near ottom, only very few floating algal mats.

g green Enteromorpha and Chaetomorpha; algal masses chiefly near bottom, only few floating lgal mats.

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Chaetomorpha overgrown with Oscillatoria, Chamaesiphonaceae, Chlamydobacteriaceae etc.; ld algal masses cheafly near bottom, only a few old floating algal mats; kepala timah present.

already rather thick Enteromorpha; among the Enteromorpha Copepods and Gammaridea; nly few floating algal mats; kepala timah present.

green Chaetomorpha, slightly or not coated; among the Chaetomorpha Ostracods, Gammaridea nd Copepods; algal masses chiefly floating; kepala timah present.

sive floating algal masses; Chaetomorpha partly yellow, dying or dead, and coated, partly green, resh, slightly or not coated; very many kepala timah; Chironomus-larvae.

sive floating algal masses; fresh Chaetomorpha not coated at all; kepala timah present.

ld-green layer of interwoven filamentous sheath-less Schizophyceae; Oscillatoria overgrown with iolet-red Gloeocapsa (sanguinea?); extensive floating algal masses; very many kepala timah; Chironomus-larvae.

w Chaetomorpha-filaments coated at intervals; extensive floating algal masses; kepala timah present.

y yellow Chaetomorpha-filaments rather heavily coated; thin, old, yellow-green Chaetomorpha hickly covered with violet-red Gloecapsa; extensive floating algal masses; many kepala timah.

w Chaetomorpha rather heavily coated; a few Cothurnia's fixed to Chaetomorpha-filaments; xtensive floating algal masses; kepala timah present.

yellow, dead, slimy remains of Chaetomorpha, heavily coated; also green Chaetomorpha with uch less coating; extensive floating algal masses; many kepala timah.

green Chaetomorpha with very little coating; extensive floating algal masses; kepala timah resent.

tomorpha partly green and fresh, partly less fresh and coated; algal masses partly floating, artly near bottom; kepala timah present.

tomorpha green, rather fresh, with very little coating; extensive floating algal masses; kepala imah present.

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green Chaetomorpha only slightly coated; also pale yellow, dying Chaetomorpha; extensive loating algal masses; kepala timah present.

Chaetomorpha with only little coating; extensive floating algal masses; many kepala timah.

Date	Place	S ‰	Mosquito-net catches			Emerged from l[illegible] and pupae col[illegible]	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Nu[illegible] ross[illegible]
3 XII '18	Pekulitan	41.3	10	0	181	1	
„ „ „	Heemraad Oost . .	28.7	10	0	44	55	1
4 „ „	Pekulitan	52.2	6	0	14	0	
„ „ „	Heemraad Oost . .	26.2	10	2	20	12	
5 „ „	Fluit	44.6	4	0	24	1	1
„ „ „	Heemraad Oost . .	31.5	10	50	500	0	
6 „ „	Fluit	84.6	10	0	59	0	1
„ „ „	Heemraad Oost . .	28.45	4	1	103	24	
7 „ „	Fluit	70.7	8	0	41	0	
„ „ „	Heemraad Oost . .	19.2	8	1	5	34	
8 „ „	Fluit	—	10	0	60	—	
„ „ „	Heemraad Oost . .	24.0	10	1	13	—	
9 „ „	Fluit	49.8	7	0	20	0	
„ „ „	Heemraad Oost . .	20.0	10	0	4	35	
10 „ „	Fluit, Djembatan Tomes .	54.1	5	0	28	—	
„ „ „	Heemraad Oost . .	18.7	—	—	—	2	
11 „ „	Fluit, Djembatan Tomes .	44.6	2	0	14	0	1
„ „ „	Heemraad Oost . .	25.8	9	51	2[illegible]7	21	
12 „ „	Muara Karang . . .	54.8	10	0	301	0	2

Submerged vegetation etc.

tomorpha rather heavily coated but still green, also heavily coated Chaetomorpha thickly covered vith violet-red Gloeocapsa; extensive floating algal masses; kepala timah present.

young Enteromorpha; Chaetomorpha rather heavily coated, also Chaetomorpha with much less oating, turning however already a little yellow-green; extensive floating algal masses; many epala timah.

ellow-green Chaetomorpha rather heavily coated, also yellow dying Chaetomorpha very heavily oated; extensive floating algal masses; many kepala timah.

Najas; young fresh-green Enteromorpha; Chaetomorpha rather fresh-green with only little oating; extensive floating algal masses; many kepala timah.

g thin Enteromorpha; fresh beautifully green Chaetomorpha with no coating at all, also Chaetomorpha with an uncommonly heavy coating; extensive floating algal masses; kepala timah present.

rk green mass of Lyngbya; fresh Enteromorpha; extensive floating algal masses; kepala imah present.

tomorpha dying, yellow, coated, but also fresh-green Chaetomorpha-filaments with very little oating together with Chaetomorpha-filaments in intermediate stages; extensive floating algal masses; kepala timah present.

g fresh-green Enteromorpha; pale yellow-green rather elongated Chaetomorpha-cells not heavily coated; extensive floating algal masses; kepala timah present.

mostly rather dark green Chaetomorpha slightly coated to more or less heavily coated, also dead Chaetomorpha clad with a red-brown coating; extensive floating masses of mostly old, dying algae; few kepala timah.

elongated Chaetomorpha-cells, more or less coated; pale yellow-green Enteromorpha; floating algal masses extending over the whole area of the pond; few kepala timah.

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ow-green, dying Chaetomorpha with nearly no coating, further fresh-green Chaetomorpha with greenish black flocks of interwoven filamentous Schizophyceae; algal masses chiefly near bottom, only few floating algal mats; very many kepala timah.

h Enteromorpha; floating algal masses extending over the whole area of the pond; few kepala timah.

yellow, thin Chaetomorpha-filaments rather heavily coated and partly covered with Chroococcaceae; algal masses chiefly near bottom, only few floating algal mats; kepala timah present.

ng Enteromorpha; floating algal masses extending over the whole area of the pond; few kepala timah.

green Chaetomorpha not coated; rather thick filaments of a Schizophycea and very thin, interwoven filaments of an other Schizophycea; extensive floating algal masses; many kepala timah.

etomorpha yellow, dying, mixed with yellowish filaments of a Schizophycea and brown, very thin, interwoven filaments of an other Schizophycea, also fine green Chaetomorpha and fine dark-green filamentous Schizophyceae; algal masses for the greater part floating, for the lesser part near bottom; kepala timah present.

etomorpha pale to dark green, heavily coated but also pale yellow, much less coated; Copepods among the Chaetomorpha-filaments; extensive floating algal masses, also algae near bottom; many kepala timah.

Date	Place	S ‰	Mosquito-net catches			Emerged from and pupae co…	
			Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Nu… ros…
12 XII '18	Heemraad Oost . .	26.9	10	293	1037	58	[illegible]
13 „ „	Muara Karang . . .	46.9	5	0	282	0	
„ „ „	Heemraad Oost . .	24.2	9	88	334	17	1
14 „ „	Muara Karang . . .	46.5	6	0	29	0	
„ „ „	Jaagpad	32.0	8	0	41	0	
15 „ „	Muara Karang . . .	46.4	10	0	244	—	
„ „ „	Jaagpad	38.7	6	0	111	—	
16 „ „	Muara Karang . . .	40.7	6	0	266	—	
„ „ „	Jaagpad	26.4	10	0	156	—	
17 „ „	Muara Karang . . .	38.3	6	0	168	0	
„ „ „	Jaagpad	32.2	—	—	—	0	1
18 „ „	Muara Karang . . .	48.9	5	0	88	0	1
„ „ „	Heemraad Oost . .	20.8	—	—	—	—	
19 „ „	Muara Karang . . .	43.6	2	0	31	0	[illegible]
„ „ „	Heemraad Oost . .	23.1	—	—	—	—	
„ „ „	„	13.5	—	—	—	—	
20 „ „	Muara Karang . . .	42.1	7	0	18	0	[illegible]
„ „ „	Heemraad Oost . .	23.0	—	—	—	—	
21 „ „	Muara Karang . . .	52.3	—	—	—	0	1
„ „ „	Heemraad Oost . .	23.3	—	—	—	—	
22 „ „	Luar Batang. . . .	24.6	9	9	113	—	
„ „ „	Heemraad Oost . .	24.9	—	—	—	—	

Submerged vegetation etc.
ɜtomorpha yellow, dying, heavily coated but also fresh-green Chaetomorpha with nearly no coating at all, together with Chaetomorpha in intermediate stages; floating algal masses; kepala timah present.
ıg, fresh-green Chaetomorpha and remains of an older Chaetomorpha-vegetation with many thin, interwoven filaments of a Schyzophycea and Gloeocapsa; only few dying and very few live algal mats floating at the water-surface; kepala timah present.
fresh Enteromorpha; fine fresh Chaetomorpha, also less fresh Chaetomorpha more or less coated; floating algal masses; kepala timah present.
ı Enteromorpha; fresh Chaetomorpha but also heavily coated remains of an old Chaetomorpha-vegetation; extensive floating algal masses, partly old and dying, partly fresh; many kepala timah.
ı, thin Enteromorpha; Chaetomorpha partly not, partly heavily coated; extensive floating algal masses; kepala timah present.
—
—
—
—
fresh-green but also pale, coated Chaetomorpha; extensive old algal masses near bottom, few young floating algal mats; kepala timah present.
brown Chaetomorpha very heavily coated; also green Chaetomorpha slightly coated; extensive floating algal masses mostly old and dying, sometimes young; kepala timah present.
etomorpha fresh green with first traces of heavy coating; also old, yellow-brown, coated Chaetomorpha; extensive floating algal masses mostly old, sometimes fresh; kepala timah present.
h, young Enteromorpha; fresh-green Chaetomorpha mixed with Oscillatoria-filaments; extensive floating algal masses; few kepala timah.
: yellow-green Chaetomorpha more or less coated; extensive floating algal masses, mostly old, sometimes fresh; very many kepala timah.
h Enteromorpha; Chaetomorpha pale yellow-green to dark green, more or less coated, mixed with Oscillatoria-filaments; extensive floating algal masses; kepala timah present.
—
: green elongated Chaetomorpha-cells with a more or less heavy, dark coating; extensive floating algal masses mostly old, sometimes fresh; many kepala timah.
k green to yellow-brown, dead Chaetomorpha, more or less coated, mixed with Oscillatoria-filaments; extensive floating algal masses; kepala timah present.
: fresh-green and yellow slightly coated Chaetomorpha; extensive old and young floating algal masses; few kepala timah.
ıh Enteromorpha; green Chaetomorpha more or less coated; extensive floating algal masses; kepala timah present.
—
—

Date	Place	$S\ ^0/_{00}$	Mosquito-net catches			Emerged fron and pupae c	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	N ro
23 XII '18	Luar Batang	28.3	10	6	50	3	
„ „ „	Heemraad Oost. . .	25.2	—	—	—	—	
24 „ „	Luar Batang. . . .	28.9	2	4	4	5	
25 „ „	„	30.25	3	—	—	—	
27 „ „	Jaagpad	30.5	5	0	5	4	
„ „ „	„	29.8	5	2	70	—	
28 „ „	„	42.4	5	0	43	—	
„ „ „	„	30.2	5	5	38	6	
29 „ „	„	30.7	10	31	269	—	
30 „ „	„	32.7	5	0	57	0	
„ „ „	„	44.2	5	0	10	—	
„ „ „	Heemraad Oost. . .	22.5	—	—	—	—	
31 „ „	Jaagpad	33.5	5	0	1	—	
„ „ „	„	38.1	5	0	12	2	
2 I '19	„	37.4	5	0	4	0	
„ „ „	„	39.9	5	0	7	0	
3 „ „	„	37.4	5	0	9	0	
„ „ „	„	38.1	5	0	30	0	
4 „ „	„	42.8	5	1	101	—	
„ „ „	„	40.7	5	0	38	—	
5 „ „	„	31.2	10	0	4	—	
6 „ „	„	42.4	5	0	23	—	

Submerged vegetation etc.
fresh-green but also old and yellow Chaetomorpha with no coating at all; fresh Enteromorpha.
—
etomorpha more or less coated.
—
sh Enteromorpha; very fine, fresh, pale green Chaetomorpha with no coating at all, also less fresh Chaetomorpha more or less coated; extensive fresh floating algal masses; few kepala timah.
sh Enteromorpha; Chaetomorpha rather heavily coated; old algal masses sunken to the pond-bottom, few young floating algal mats; many kepala timah.
ing and old Chaetomorpha, slightly to very heavily coated; extensive floating algal masses, mostly old, sometimes young; very few kepala timah.
teromorpha; Chaetomorpha more or less coated; extensive young, fresh, floating algal masses, some old algal mats sunken to bottom, many kepala timah.
—
er Chaetomorpha more or less heavily coated; extensive floating algal masses, mostly old, sometimes young and fresh; few kepala timah.
sh Enteromorpha; very fine young and fresh but also old, coated Chaetomorpha; extensive, chiefly old, floating algal masses; very few kepala timah.
—
aetomorpha young, fresh-green to yellowish and coated; extensive floating algal masses; few kepala timah.
aetomorpha mostly very heavily, sometimes somewhat less heavily coated, colour green to red-brown; extensive, chiefly old, floating algal masses; few kepala timah.
ler Chaetomorpha more or less heavily coated and covered with a rich red Gloeocapsa-vegetation; extensive, chiefly old, floating algal masses; many kepala timah.
sh young Enteromorpha; fresh young Chaetomorpha; older Chaetomorpha more or less heavily coated; extensive, chiefly old, floating algal masses; many kepala timah.
ung Enteromorpha; young to old Chaetomorpha, also empty Chaetomorpha cell-walls more or less heavily coated; partly old, partly young and fresh floating algal masses extending over whole pond-area; many kepala timah,
re or less to very heavily coated Chaetomorpha in all stages between rather young and remains of cell-walls; extensive floating algal masses; many kepala timah with many young ones.
her dark green young to old Chaetomorpha, more or less coated; Enteromorpha; floating algal masses extending over whole pond-area; many, especially young, kepala timah.
ler, thin, dark green Chaetomorpha, slightly to very heavily coated; old and young floating algal masses extending nearly over whole pond-area; many kepala timah.
—
l sometimes partly decayed Chaetomorpha, more or less heavily coated; Ruppia rostellata; extensive old algal masses near bottom, few young floating algal mats; many kepala timah.

Date	Place	S ‰	Mosquito-net catches			Emerged from l… and pupae coll…	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Nu… ross…
6 I '19	Jaagpad	32.4	5	0	20	—	
7 „ „	„	38.7	5	0	82	—	
„ „ „	„	48.1	4	0	77	—	
8 „ „	Heemraad Oost . .	38.1	8	3	91	—	
„ „ „	„ . .	16.6	5	0	0	—	
9 „ „	„ . .	33.6	4	1	49	—	
„ „ „	„ . .	16.9	5	0	44	—	
10 „ „	„ . .	32.7	4	3	35	—	
„ „ „	„ . .	18.7	4	2	16	—	
11 „ „	„ . .	34.85	5	0	137	—	
„ „ „	„ . .	19.9	5	7	75	—	
12 „ „	„ . .	34.4	—	—	—	—	
„ „ „	„ . .	20.3	—	—	—	—	
14 „ „	„ . .	25.1	4	2	101	—	
„ „ „	„ . .	9.9	5	2	36	—	
15 „ „	„ . .	27.9	2	3	18	—	
„ „ „	„ . .	15.2	2	4	43	—	
16 „ „	„ . .	27.0	4	6	87	—	
„ „ „	„ . .	14.0	5	5	35	—	
17 „ „	„ . .	27.85	2	4	68	—	
„ „ „	„ . .	16.2	2	0	5	—	
18 „ „	„ . .	27.4	1	1	30	—	
„ „ „	„ . .	15.1	5	14	29	—	

Submerged vegetation etc.
etomorpha rather heavily coated, mostly old, sometimes young floating algal masses; few kepala timah.
h Enteromorpha; Chaetomorpha rather fresh, more or less coated; few floating algal mats; kepala timah none visible.
ıer young and fresh to older, very pale, rather heavily coated Chaetomorpha, sometimes with Gloeocapsa; floating algal masses extending over whole pond-area; kepala timah none visible.
—
—
—
—
ı and thick Enteromorpha.
as falciculata.
ı and thick Enteromorpha.
jas falciculata.
teromorpha; very thin, dark green Chaetomorpha-filaments.
jas falciculata.
n and thick Enteromorpha mixed with some thin Chaetomorpha-filaments with thick cell-walls.
jas falciculata.
ung fresh Enteromorpha; thin Chaetomorpha-filaments with thick cell-walls, not coated.
jas falciculata; old Enteromorpha; rather thick Chaetomorpha-filaments with thin cell-walls, darkly coated at intervals.
n and thick Enteromorpha; fresh Chaetomorpha with thin cell-walls.
ıjas falciculata; dark blue-green mass consisting of thin, interwoven, filamentous Schizophyceae; Copepods, Gammaridea, Ostracods, Turbellaria.
ıteromorpha and fresh thick Chaetomorpha-filaments with thin cell-walls.
ıjas falciculata and a felt-like mass of thin interwoven filamentous Schizophyceae.
ıteromorpha and thin Chaetomorpha-filaments with thick cell-walls.
ıjas falciculata and a felt-like mass of thin interwoven filamentous Schizophyceae.

Date			Place	S ‰	Mosquito-net catches			Emerged from l and pupae coll	
					Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Nur (ross
19	1	'19	Heemraad Oost . .	16.4	5	8	65	—	
”	”	”	” . .	27.5	5	1	7	—	
20	”	”	” . .	28.4	5	4	152	—	
”	”	”	” . .	17.9	5	4	15	—	
21	”	”	” . .	28.5	5	4	93	—	
”	”	”	” . .	18.2	—	—	—	—	
22	”	”	” . .	28.6	4	3	50	—	
”	”	”	” . .	20.1	5	12	74	—	
23	”	”	” . .	29.3	5	4	62	—	
”	”	”	” . .	21.7	4	—	—	—	
24	”	”	” . .	29.9	5	4	42	—	
”	”	”	” . .	20.2	3	2	8	—	
25	”	”	” . .	30.0	5	6	53	—	
”	”	”	” . .	23.9	3	3	22	—	
26	”	”	” . .	30.3	4	6	52	—	
”	”	”	” . .	19.2	3	3	32	—	
27	”	”	” . .	30.0	4	3	15	—	
”	”	”	” . .	21.8	—	—	—	—	
28	”	”	” . .	30.8	—	—	—	—	
”	”	”	” . .	22.75	3	2	9	—	
29	”	”	” . .	30.7	4	2	15	—	
”	”	”	” . .	26.7	—	—	—	—	
30	”	”	” . .	24.65	—	—	—	—	

Submerged vegetation etc.
romorpha and thin Chaetomorpha-filaments.
s falciculata.
romorpha and fresh thin Chaetomorpha-filaments.
s falciculata.
romorpha; thick Chaetomorpha-filaments with thin cell-walls, heavily coated.
s falciculata.
romorpha; thick Chaetomorpha-filaments with thin cell-walls, heavily coated.
s falciculata.
romorpha; thin Chaetomorpha-filaments with thick cell-walls.
s falciculata.
romorpha; thick Chaetomorpha-filaments with thin cell-walls, partly with a heavy dark coating.
s falciculata.
romorpha and Chaetomorpha with a rather heavy dark coating.
s falciculata.
romorpha; thick Chaetomorpha-filaments with thin cell-walls, partly with a heavy dark coating.
s falciculata.
romorpha; thin Chaetomorpha-filaments rather heavily coated.
s falciculata.
eromorpha and Chaetomorpha.
as falciculata and Enteromorpha.
Chaetomorpha with a very heavy nearly black coating; Enteromorpha.
as falciculata and Enteromorpha.
eromorpha and Chaetomorpha.

Date			Place	$S^0/_{00}$	Mosquito-net catches			Emerged from la and pupae coll	
					Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Num o rossi
30	I	'19	Heemraad Oost . .	32.6	—	—	—	—	—
31	„	„	„ . .	28.1	4	1	11	—	—
„	„	„	„ . .	15.0	—	—	—	—	—
1	II	„	Jaagpad	24.3	—	—	—	—	—
„	„	„	„	31.9	—	—	—	—	—
2	„	„	„	37.4	3	0	28	—	—
„	„	„	„	37.4	3	1	27	—	—
3	„	„	„	39.0	1	0	49	—	—
„	„	„	„	38.5	1	0	120	—	—
4	„	„	„	38.8	3	0	130	—	—
„	„	„	„	40.1	4	0	53	—	—
....			....	....	....	....	....	....	....
5	„	„	„	22.7	3	2	115	—	—
„	„	„	„	13.2	3	2	182	—	—
....			....	....	....	....	....	....	....
6	„	„	„	14.8	5	0	23	—	—
„	„	„	„	3.4	3	0	8	—	—
7	„	„	„	4 25	4	0	46	—	—
„	„	„	„	11.8	2	0	11	—	—
8	„	„	„	11.1	3	0	37	—	—
„	„	„	„	8.6	4	0	34	—	—
9	„	„	„	10.3	3	0	17	—	—
„	„	„	„	10.3	—	—	—	—	—

Submerged vegetation etc.
ajas falciculata and Schizophyceae.
nteromorpha and thin Chaetomorpha-filaments.
lajas falciculata; young Enteromorpha; thin interwoven filamentous Schizophyceae.
oung and old Chaetomorpha with Gloeocapsa and Schizophyceae.
nteromorpha; old and young Chaetomorpha.
oung thin filaments of Chaetomorpha and remains of an old vegetation of coated Chaetomorpha-filaments.
nteromorpha.
oung and fresh Enteromorpha; old Chaetomorpha heavily coated.
nteromorpha; old Chaetomorpha heavily coated.
nteromorpha; old coated Chaetomorpha, also young Chaetomorpha.
nteromorpha; Chaetomorpha with thin cell-walls.
.... rains (32 mm.)
ld Chaetomorpha with a heavy black coating; Enteromorpha.
nteromorpha.
.... heavy rains (94 mm.)
ld and young Chaetomorpha.
nteromorpha and Chaetomorpha.
nteromorpha and fresh Chaetomorpha.
haetomorpha with filamentous Schizophyceae and Gloeocapsa.
ld and young Chaetomorpha.
oung and old Chaetomorpha, green and yellow.
haetomorpha young, fresh-green to old, yellow-brown, coated.
ld coated Chaetomorpha.

Date			Place	S ‰	Mosquito-net catches			Emerged from and pupae col	
					Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Nu ros
10	II	'19	Jaagpad	10.9	4	6	97	—	
„	„	„	„	10.1	4	3	14	—	
11	„	„	„	11.3	3	3	13	—	
„	„	„	„	10.8	4	0	134	—	
12	„	„	„	11.5	3	0	54	—	
„	„	„	„	11.1	4	0	45	—	
13	„	„	„	13.2	2	1	9	—	
„	„	„	„	11.7	4	0	62	—	
14	„	„	„	12.5	3	0	54	—	
„	„	„	„	12.4	4	0	97	—	
15	„	„	„	8.2	4	0	91	—	
„	„	„	„	6.4	3	0	37	—	
16	„	„	„	8.7	4	0	22	—	
„	„	„	„	4.4	4	0	55	—	
17	„	„	„	8.6	3	0	20	—	
„	„	„	„	7.5	3	0	34	—	
18	„	„	„	8.7	—	—	—	—	
„	„	„	„	8.6	—	—	—	—	
19	„	„	„	6.0	—	—	—	—	
„	„	„	„	9.1	—	—	—	—	
20	„	„	„	8.8	—	—	—	—	
„	„	„	„	11.0	—	—	—	—	
21	„	„	„	8.9	—	—	—	—	

Submerged vegetation etc.
teromorpha and Chaetomorpha.
ppia rostellata and Chaetomorpha.
e Chaetomorpha.
aetomorpha young and fresh to old and coated.
aetomorpha, partly fresh-green.
teromorpha; Chaetomorpha partly fresh-green.
aetomorpha partly fresh-green.
aetomorpha partly fresh-green.
aetomorpha partly fresh-green.
ppia rostellata; Chaetomorpha young and fresh-green but also older dark or pale-yellow Chaetomorpha-filaments with more or less coating.
teromorpha; Chaetomorpha more or less heavily coated.
d and very old Chaetomorpha more or less heavily coated.
teromorpha; Chaetomorpha.
d and very old Chaetomorpha more or less heavily coated.
ther fresh Chaetomorpha more or less heavily coated.
d and very old Chaetomorpha sometimes with Gloeocapsa.
d and very old Chaetomorpha more or less heavily coated.
d and very old Chaetomorpha more or less heavily coated.
uppia rostellata; old and less old Chaetomorpha.
ther young to very old Chaetomorpha.
ther young Chaetomorpha more or less heavily coated.
haetomorpha heavily coated.
ther fresh Chaetomorpha, rather heavily coated.

Date			Place	S ‰	Mosquito-net catches			Emerged from and pupae	
					Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	N ro
21	II	'19	Jaagpad	9.1	—	—	—	—	
18	III	„	Luar Batang	14.5	—	—	—	—	
„	„	„	Pekulitan	18.7	—	—	—	—	
19	„	„	Luar Batang	15.6	—	—	—	—	
„	„	„	Pekulitan	19.2	—	—	—	—	
20	„	„	Luar Batang	25.7	6	4	44	8	
„	„	„	Pekulitan	8.1	6	1	16	5	
21	„	„	Luar Batang	26.5	7	4	119	5	
„	„	„	Pekulitan	13.5	8	2	49	4	
22	„	„	Luar Batang	27.1	7	1	44	16	1
„	„	„	Pekulitan	6.7	8	15	129	23	2
23	„	„	Luar Batang	28.5	7	1	32	—	
„	„	„	Pekulitan	6.3	8	0	26	—	
24	„	„	Luar Batang	28.3	7	0	14	9	1
„	„	„	Pekulitan	22.0	8	0	18	1	
25	„	„	Luar Batang	28.2	7	0	20	—	
„	„	„	Pekulitan	25.0	8	0	17	2	1
26	„	„	Luar Batang	23.9	7	1	30	5	
„	„	„	Pekulitan	23.9	8	0	15	0	
27	„	„	Luar Batang	23.9	7	2	13	10	1
„	„	„	Pekulitan	13.2	8	4	44	1	
28	„	„	Luar Batang	24.3	7	0	10	12	1
„	„	„	Fluit	12.1	8	3	113	3	

Submerged vegetation etc.
d and very old Chaetomorpha heavily coated, also very fresh Chaetomorpha.
nteromorpha; Najas falciculata.
naetomorpha; floating algal masses; kepala timah present.
ajas falciculata; Enteromorpha.
uppia rostellata; Chaetomorpha; floating algal masses; very many kepala timah.
nteromorpha; Chaetomorpha.
naetomorpha; Enteromorpha; floating algal masses; kepala timah present.
esh Chaetomorpha with thin cell-walls; Enteromorpha.
nteromorpha; Najas falciculata; few floating algal masses; kepala timah present.
oung and fresh Chaetomorpha; Enteromorpha.
ajas falciculata; Enteromorpha; very few floating algal masses; kepala timah present.
ery fine young Enteromorpha and Chaetomorpha.
haetomorpha; Ruppia rostellata; floating algal masses; kepala timah present.

Date			Place	$S\,^0/_{00}$	Mosquito-net catches			Emerged fr and pupae
					Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀
29	III	'19	Luar Batang. . . .	11.5	7	19	119	7
„	„	„	Fluit	12.95	8	2	53	3
30	„	„	Luar Batang. . . .	7.15	7	13	82	—
„	„	„	Fluit	5.2	8	4	34	—
31	„	„	Luar Batang. . . .	12.8	7	1	11	13
„	„	„	Fluit	3.7	8	0	13	16
1	IV	„	Luar Batang. . . .	13.4	8	3	88	2
„	„	„	Fluit	4.7	8	3	20	19
2	„	„	Luar Batang. . . .	13.75	7	3	14	9
„	„	„	Fluit	3.7	8	8	28	17
3	„	„	Luar Batang. . . .	12.9	7	6	100	5
„	„	„	Fluit	3.8	8	7	38	62
4	„	„	Jaagpad	26.4	7	20	165	11
„	„	„	Fluit	9.6	8	2	37	21
5	„	„	Jaagpad	26.9	7	2	29	10
„	„	„	Fluit	5.2	8	5	41	33
6	„	„	Jaagpad	25.9	7	5	40	—
„	„	„	Fluit	5.2	8	0	32	—
7	„	„	Jaagpad	26.5	7	3	97	2
„	„	„	Fluit	11.8	8	6	41	38
8	„	„	Jaagpad	27.1	7	4	189	0
„	„	„	Fluit	15.4	8	0	26	16
9	„	„	Jaagpad	27.5	7	4	103	5

ate	Place	S ‰	Mosquito-net catches			Emerged from larvae and pupae collected	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Number of rossii ♀♀
IV '19	Fluit	15.6	8	0	16	26	105
„ „	Jaagpad	28.15	7	34	84	9	21
„ „	Fluit	14.4	8	6	169	12	61
„ „	Jaagpad	28.95	7	13	173	6	70
„ „	Fluit	15.9	8	0	23	0	28
„ „	Jaagpad	29.2	7	5	65	1	16
„ „	Fluit	16.1	8	0	12	0	10
„ „	Jaagpad	29.7	7	5	28	—	—
„ „	Fluit	16.6	8	0	8	—	—
„ „	Jaagpad	28.7	7	19	80	—	—
„ „	Fluit	16.9	8	0	13	5	29
„ „	Heemraad	13.7	7	71	26	73	15
„ „	Muara Pegantungan .	21.5	8	0	5	0	21
„ „	Heemraad	11.3	7	215	38	149	28
„ „	Muara Pegantungan .	18.2	8	0	2	1	18
„ „	Heemraad	11.4	7	46	17	147	15
„ „	Muara Pegantungan .	18.2	8	0	5	3	15
„ „	Heemraad	11.05	7	114	35	94	10
„ „	Muara Pegantungan .	19.5	8	0	8	1	50
„ „	Heemraad	13.1	7	129	141	111	11
„ „	Muara Pegantungan .	18.1	8	0	11	2	23
„ „	Heemraad	10.9	7	56	7	113	12
„ „	Muara Pegantungan .	14.9	8	0	6	4	73

Date	Place	S ⁰/₀₀	Mosquito-net catches			Emerged from and pupae c	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	N ro
21 IV '19	Heemraad	10.9	7	150	12	—	
„ „ „	Muara Pegantungan .	13.5	8	0	10	—	
22 „ „	Heemraad	10.2	7	114	12	—	
„ „ „	Muara Pegantungan .	13.2	8	0	4	—	
23 „ „	Heemraad	9.7	7	4	0	113	
„ „ „	Muara Pegantungan .	7.9	8	1	20	6	
24 „ „	Heemraad	10.8	7	65	10	88	
„ „ „	Muara Karang . . .	8.4	8	3	79	5	
25 „ „	Heemraad	10.55	—	—	—	—	
„ „ „	Muara Karang . . .	8.15	8	6	55	48	
26 „ „	Heemraad	11.1	7	25	4	1	
„ „ „	Muara Karang . . .	8.4	8	0	46	6	
27 „ „	Heemraad Oost . .	11.9	7	24	2	—	
„ „ „	Muara Karang . . .	8.8	8	0	31	—	
28 „ „	Heemraad Oost . .	12.3	7	0	1	129	
„ „ „	Muara Karang . . .	8.55	8	0	7	5	
29 „ „	Heemraad Oost . .	12.6	7	30	1	53	
„ „ „	Muara Karang . . .	8.6	8	0	7	10	
30 „ „	Heemraad Oost . .	12.8	7	14	4	101	
„ „ „	Muara Karang . . .	11.8	8	5	43	—	
1 V „	Heemraad Oost . .	12.5	7	2	3	18	
„ „ „	Muara Karang . . .	12.6	8	4	35	7	
2 „ „	Heemraad Oost . .	14.1	7	117	14	60	

Submerged vegetation etc.
:at quantities of Oscillatoria; Chaetomorpha; Enteromorpha.

Date			Place	S $^0/_{00}$	Mosquito-net catches			Emerged from l… and pupae coll…	
					Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Nu… ross…
2	V	'19	Muara Karang . . .	12.7	8	0	23	4	7
3	„	„	Heemraad Oost . .	13.5	7	74	18	120	2
„	„	„	Muara Karang . . .	12.8	8	3	22	16	10
4	„	„	Heemraad Oost . .	12.7	7	40	10	—	-
„	„	„	Muara Karang . . .	12.8	8	3	18	—	-
5	„	„	Heemraad Oost . .	10,0	7	86	15	99	
„	„	„	Muara Karang . . .	5.5	8	0	10	12	3
6	„	„	Heemraad Oost . .	11.2	7	63	22	49	
„	„	„	Muara Karang . . .	9.7	8	10	24	41	7
7	„	„	Heemraad Oost . .	10.1	7	79	12	75	2
„	„	„	Muara Karang . . .	12.9	8	0	5	15	8
8	„	„	Heemraad Oost . .	10.2	7	18	13	68	
„	„	„	Muara Karang . . .	4.7	8	0	12	3	5
9	„	„	Heemraad Oost . .	8.6	7	75	12	110	1
„	„	„	Muara Karang . . .	4.2	8	0	10	2	7
10	„	„	Heemraad Oost . .	9,8	10	152	17	96	1
„	„	„	Muara Karang . . .	4.35	8	0	19	9	10
11	„	„	Heemraad Oost . .	10,2	10	212	10	—	-
„	„	„	Muara Karang . . .	3.95	8	0	24	—	-
12	„	„	Heemraad Oost . .	10.8	10	211	34	69	
„	„	„	Muara Karang . . .	4.4	8	5	19	4	10
13	„	„	Heemraad Oost . .	10.0	10	175	19	135	1
„	„	„	Muara Karang . . .	4.8	8	0	5	2	6

Submerged vegetation etc.
sh Najas falciculata; fresh Enteromorpha; fresh Chaetomorpha; fresh Spirogyra.
ung and fresh Spirogyra; young fresh, and old Enteromorpha; old Chaetomorpha.
jas falciculata; Oscillatoria; Enteromorpha; Chaetomorpha.
jas falciculata; Oscillatoria; Spirogyra; Chaetomorpha.
:at quantities of Oscillatoria; Najas falciculata; Enteromorpha.
cillatoria; Enteromorpha; Spirogyra; Chaetomorpha; Najas falciculata.
cillatoria; Najas falciculata; Enteromorpha; Chaetomorpha.
cillatoria and Spirogyra; among these algae Anguillulidae, Ostracods and Copepods
jas falciculata; Enteromorpha; Oscillatoria.
irogyra; Oscillatoria.
ijas falciculata; Oscillatoria; Enteromorpha.
irogyra; Oscillatoria.
ijas falciculata; Chaetomorpha; Enteromorpha.
irogyra.
ajas falciculata; Enteromorpha; Chaetomorpha; Oscillatoria.
irogyra; Oscillatoria.
ajas falciculata; Enteromorpha Oscillatoria.
ajas falciculata; Enteromorpha.

Date	Place	S⁰/₀₀	Mosquito-net catches			Emerged from la… and pupae colle…	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	Num… of rossii
14 V '19	Heemraad Oost . .	10.5	10	91	34	63	1
„ „ „	Muara Karang . . .	6.1	8	0	23	11	15
15 „ „	Heemraad Oost . .	10.7	10	87	45	112	5
„ „ „	Muara Karang . . .	7.45	8	2	71	7	6
16 „ „	Heemraad Oost . .	10.3	10	131	26	71	3
„ „ „	Muara Karang . . .	8.5	8	0	7	1	2
17 „ „	Heemraad Oost . .	10.4	10	107	59	38	1
„ „ „	Muara Karang . . .	6.7	8	0	33	5	5
18 „ „	Heemraad Oost . .	10.3	10	92	28	—	—
„ „ „	Muara Karang . . .	8.4	8	0	10	—	—
19 „ „	Heemraad Oost . .	10.3	10	117	15	59	
„ „ „	Muara Karang . . .	5.45	8	0	10	5	4
20 „ „	Heemraad Oost . .	10.8	10	83	9	111	3
„ „ „	Muara Karang . . .	8.5	8	0	14	4	5
21 „ „	Heemraad Oost . .	10.0	10	289	59	47	
„ „ „	Muara Karang . . .	19.1	8	0	29	5	7
22 „ „	Muara Antjol . . .	20.3	10	7	0	87	
„ „ „	Muara Karang . . .	19.45	8	0	4	3	[illegible]
23 „ „	Jaagpad	26.5	10	17	51	—	—
„ „ „	Muara Karang . . .	18.4	8	2	43	1	[illegible]
24 „ „	Jaagpad	26.8	10	120	126	—	—
„ „ „	Muara Karang . . .	19.1	8	2	23	2	[illegible]
25 „ „	Jaagpad	27.5	10	15	32	—	[illegible]

Submerged vegetation etc.
ıjas falciculata; Enteromorpha; Oscillatoria.
ajas falciculata; Enteromorpha.
ajas falciculata; Enteromorpha; Oscillatoria.
ajas falciculata; Enteromorpha.
ajas falciculata; Enteromorpha; Oscillatoria.
nteromorpha.
ajas falciculata; Enteromorpha; Oscillatoria.
nteromorpha.
ajas falciculata; Enteromorpha; Oscillatoria.
ajas falciculata; Enteromorpha.
lajas falciculata; Enteromorpha; Oscillatoria.
nteromorpha; Najas falciculata.
lajas falciculata; great quantities of young Enteromorpha; some old Chaetomorpha-filaments.
lajas falciculata; Enteromorpha; some Chaetomorpha-filaments.
lajas falciculata; Enteromorpha; Oscillatoria.
young Enteromorpha and Chaetomorpha.
Ruppia rostellata; Oscillatoria; some Chaetomorpha-filaments.
Ruppia rostellata; Chaetomorpha.
old Chaetomorpha.
Ruppia rostellata; Najas falciculata; Chaetomorpha.
Chaetomorpha.
Chaetomorpha.
Chaetomorpha.

Date			Place	S ‰	Mosquito-net catches			Emerged from la and pupae colle	
					Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Num o rossi
25	V	'19	Muara Karang . . .	19.3	8	1	28	—	-
26	„	„	Jaagpad	24.45	10	1	6	—	-
„	„	„	Muara Karang . . .	15.0	8	0	8	7	10
27	„	„	Jaagpad	24.7	10	5	27	—	-
„	„	„	Muara Karang . . .	15.9	8	1	21	9	8
28	„	„	Jaagpad	25.9	10	5	51	—	-
„	„	„	Pekulitan	9.0	8	8	72	19	8
29	„	„	Jaagpad	27.55	10	24	36	—	-
„	„	„	Pekulitan	8.8	8	3	25	—	-
30	„	„	Jaagpad	28.9	10	26	80	—	-
„	„	„	Pekulitan	8.7	8	20	70	—	-
31	„	„	Jaagpad	28.35	10	57	167	102	5
„	„	„	Pekulitan	8.2	8	13	76	45	4
1	VI	„	Jaagpad	26.7	10	18	108	—	-
„	„	„	Pekulitan	8.2	8	47	113	—	-
2	„	„	Jaagpad	23.4	10	8	30	4	
„	„	„	Pekulitan	5.75	8	15	45	25	2
3	„	„	Jaagpad	4.2	10	13	58	14	2
„	„	„	Pekulitan	5.6	8	7	11	16	2
4	„	„	Jaagpad	4.3	10	56	72	14	1
„	„	„	Pekulitan	5.1	8	0	6	8	
5	„	„	Jaagpad	5.6	10	23	63	7	2
„	„	„	Pekulitan	5.9	8	5	18	15	1

Submerged vegetation etc.
as falciculata and young Enteromorpha.
ıetomorpha.
as falciculata; Oscillatoria.
: young green Chaetomorpha.
as falciculata and Enteromorpha.
: green Chaetomorpha.
ıng and older Enteromorpha.

Date	Place	S ‰	Mosquito-net catches			Emerged fror and pupae (	
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀	N ro
6 VI '19	Jaagpad	5.6	10	9	41	17	
" " "	Pekulitan	6.3	8	0	5	38	
7 " "	Jaagpad	12.6	10	13	28	—	
" " "	Pekulitan	5.4	8	2	9	39	
8 " "	Jaagpad	19.0	10	0	4	—	
" " "	Pekulitan	5.4	8	40	66	—	
9 " "	Jaagpad	18.1	10	29	48	—	
" " "	Pekulitan	4.2	8	5	4	—	
10 " "	Jaagpad	18.2	10	74	118	16	
" " "	Pekulitan	4.8	8	10	27	40	
11 " "	Jaagpad	18.9	10	103	105	3	
" " "	Pekulitan	5.9	8	13	21	63	
12 " "	Jaagpad	19.4	10	17	41	8	
" " "	Pekulitan	6.5	8	5	7	21	
13 " "	Jaagpad	21.1	10	3	6	—	
" " "	Pekulitan	6.5	8	23	23	12	
14 " "	Jaagpad	21.5	10	3	8	3	
" " "	Pekulitan	5.7	8	17	13	—	
15 " "	Jaagpad	22.7	10	0	11	—	
" " "	Pekulitan	4.0	8	18	22	—	
16 " "	Jaagpad	22.9	10	43	43	17	
" " "	Pekulitan	4.8	8	36	36	43	
17 " "	Jaagpad	20.8	10	0	2	16	

ate	Place	S ‰	Mosquito-net catches			Emerged from larvae and pupae collected	
			Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Number of rossii ♀♀
VI '19	Pekulitan	6.2	8	25	17	72	36
" "	Jaagpad	24.2	10	34	78	41	15
" "	Pekulitan	6.4	8	11	6	35	8
" "	Jaagpad	24.3	10	16	20	12	21
" "	Pekulitan	7.1	8	13	13	21	12
" "	Jaagpad	20.8	10	36	30	9	4
" "	Pekulitan	8.3	8	29	50	8	4
" "	Jaagpad	22.3	10	33	29	30	51
" "	Pekulitan	9.7	8	61	66	41	13
" "	Jaagpad	21.4	10	55	41	—	—
" "	Pekulitan	10.4	8	21	48	—	—
" "	Heemraad.	14.4	10	2	0	40	20
" "	Pekulitan	8.0	8	23	21	70	30
" "	Heemraad.	15.8	10	5	2	54	12
" "	Pekulitan	8.35	8	121	61	74	13
" "	Heemraad.	16.0	10	11	9	—	—
" "	Pekulitan	8.75	8	119	60	61	10
" "	Heemraad.	16.2	10	17	5	—	—
" "	Pekulitan	12.8	8	71	31	29	15
" "	Heemraad.	16.8	10	9	0	25	8
" "	Pekulitan	12.8	8	112	31	45	17
" "	Heemraad.	16.6	10	46	7	10	15
" "	Pekulitan	12.0	8	215	40	—	—

Date	Place	S ‰	Mosquito-net catches			Emerged fr and pupae
			Number of nets	Number of lud-lowi ♀♀	Number of rossii ♀♀	Number of lud-lowi ♀♀
29 VI '19	Heemraad.	16.8	10	7	2	—
„ „ „	Pekulitan	14.1	8	123	36	—
1 VII „	Heemraad.	17.2	—	—	—	—
„ „ „	Pekulitan	13.7	—	—	—	—
2 „ „	Heemraad.	17.3	10	4	5	25
„ „ „	Pekulitan	14.0	8	67	34	31
3 „ „	Heemraad.	17.5	10	25	6	31
„ „ „	Pekulitan	15.5	8	102	40	69
4 „ „	Heemraad.	18.0	10	15	2	0
„ „ „	Pegantungan. . . .	10.6	8	3	18	54
5 „ „	Heemraad.	17.8	10	3	1	5
„ „ „	Pegantungan. . . .	10.5	8	3	11	34
6 „ „	Heemraad.	15.9	10	47	13	—
„ „ „	Pegantungan. . . .	14.7	8	7	21	—
7 „ „	Heemraad.	15.9	10	50	17	30
„ „ „	Pegantungan. . . .	14.8	8	20	28	21
8 „ „	Heemraad.	16.1	10	59	26	102
„ „ „	Pegantungan. . . .	20.4	8	0	28	6
9 „ „	„	22.0	8	5	11	6
10 „ „	„	16.1	8	9	51	12
11 „ „	„	13.5	8	14	32	25
12 „ „	„	11.9	8	8	18	31
13 „ „	„	16.9	8	17	7	—

te	Place	S ‰	Mosquito-net catches			Emerged from larvae and pupae collected	
			Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Number of rossii ♀♀
II '19	Pegantungan. . . .	16.8	8	38	42	25	12
, „	„	19.35	8	3	17	35	29
, „	„	11.2	8	44	51	8	2
, „	„	14.3	8	114	64	49	25
, „	„	19.8	8	16	5	32	11
, „	„	22.2	8	42	9	—	—
, „	„	29.25	8	2	13	—	—
, „	Fluit	15.3	8	13	25	8	31
, „	Heemraad.	20.1	8	218	43	—	—
, „	„	18.1	8	407	41	0	3
, „	„	9.1	8	218	22	0	13
„ „	„	9.3	8	518	111	0	18
„ „	„	23.8	6	181	24	—	—
„ „	„	24.3	8	42	4	—	—
„ „	„	25.0	8	43	7	0	22
„ „	„	23.7	7	21	1	—	—
„ „	„	26.1	7	0	0	—	—
„ „	„	19.85	8	77	6	—	—
'III „	„	20.8	8	42	4	—	—
„ „	„	20.65	8	52	6	—	—
„ „	„	20.1	8	43	4	—	—
„ „	„	20.6	8	30	5	—	—
„ „	„	20.9	8	82	7	—	—

Date	Place	S ⁰/₀₀	Mosquito-net catches			Emerged from and pupae o[…]	
			Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	N[…] ro[…]
6 VIII'19	Heemraad	23.6	8	101	6	—	
7 „ „	„	24.3	8	54	5	—	
8 „ „	„	24.85	8	0	0	—	
9 „ „	„	25.2	10	26	1	—	
10 „ „	Heemraad Oost . .	12.8	10	7	2	—	
11 „ „	„ . .	4.8	10	24	2	—	
12 „ „	„ . .	10.0	10	13	0	—	
13 „ „	„ . .	10.3	10	45	3	—	
14 „ „	„ . .	10.8	10	18	2	—	
15 „ „	„ . .	10.5	10	30	2	—	
16 „ „	„ . .	10.7	10	50	7	—	
17 „ „	„ . .	10.5	10	45	5	—	
18 „ „	„ . .	10.5	10	74	7	—	
19 „ „	„ . .	10.6	10	75	4	—	
20 „ „	„ . .	10.8	10	80	11	—	
21 „ „	„ . .	10.9	10	187	15	—	
22 „ „	„ . .	11.2	10	132	8	—	
23 „ „	„ . .	11.1	10	124	10	—	
24 „ „	„ . .	10.8	10	203	16	—	
25 „ „	„ . .	11.4	10	94	6	—	
26 „ „	„ . .	11.4	10	28	2	—	
27 „ „	„ . .	11.4	10	112	11	—	
28 „ „	„ . .	11.0	10	144	8	—	

Submerged vegetation etc.
omorpha.
omorpha; Chaetomorpha.
omorpha; Lyngbya.
falciculata; Lyngbya.
omorpha; Lyngbya.
falciculata; Lyngbya.
falciculata; Lyngbya.
gyra; Enteromorpha; Lyngbya.
falciculata; Lyngbya.

Date	Place	S °/₀₀	Mosquito-net catches			Emerged from larvae and pupae collected	
			Number of nets	Number of ludlowi ♀♀	Number of rossii ♀♀	Number of ludlowi ♀♀	Number of rossii ♀♀
29 VIII '19	Heemraad Oost . .	9.9	10	38	7	—	—
30 „ „	„ . .	10.35	10	7	2	—	—
31 „ „	„ . .	10.35	10	1	1	—	—
1 IX „	„ . .	10.35	10	2	2	—	—
2 „ „	„ . .	11.6	10	5	2	—	—
3 „ „	„ . .	9.3	10	108	6	—	—
4 „ „	„ . .	9.4	10	99	12	—	—
5 „ „	Djembatan Tomes . .	36.1	10	5	62	—	—
6 „ „	„ . .	37.7	10	2	23	—	—
7 „ „	„ . .	37.9	10	10	186	—	—
8 „ „	„ . .	38.7	10	39	333	—	—
9 „ „	„ . .	38.9	10	6	124	—	—
10 „ „	„ . .	39.1	10	33	132	—	—
11 „ „	„ . .	39.7	10	27	377	—	—
12 „ „	„ . .	34.7	10	17	442	—	—
13 „ „	„ . .	38.7	10	3	130	—	—
14 „ „	„ . .	40.0	10	1	117	—	—
15 „ „	„ . .	40.0	10	1	41	—	—

TABLE V.

Salinities and quantitative data concerning the production of Anophelines, collected in the Batavia marine fish ponds in 1918 and 1919 and arranged topographically and in the order of the salinities; with for each 10 ‰ (or 5 ‰) of the salinity the average of the mosquito-net catches per 10 M² and per night and the total of the Anopheline ♀♀ emerged from the larvae and pupae collected.

Ponds near Muara Karang.

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
11 V '19	3.95	0		30		—		—	
9 „ „	4.2	0		12.5		2		71	
10 „ „	4.35	0		24		9		107	
12 „ „	4.4	6		24		4		100	
8 „ „	4.7	0		15		3		50	
13 „ „	4.8	0		6		2		62	
19 „ „	5.45	0		12.5		5		42	
5 „ „	5.5	0		12.5		12		33	
14 „ „	6.1	0		29		11		157	
17 „ „	6.7	0	32.5:21=	41	647:21=	5		52	
15 „ „	7.45	2.5	2	89	31	7	180	67	1124
25 IV „	8.15	7.5		69		48		7	
24 „ „	8.4	4		99		5		70	
26 „ „	8.4	0		57.5		6		51	
18 V „	8.4	0		12.5		—		—	
16 „ „	8.5	0		9		1		29	
20 „ „	8.5	0		17.5		4		59	
28 IV „	8.55	0		9		5		48	
29 „ „	8.6	0		9		10		42	
27 „ „	8.8	0		39		—		—	
6 V „	9.7	12.5		30		41		77	
30 IV '19	11.8	6		54		—		—	
1 V „	12.6	5		44		7		54	
2 „ „	12.7	0		29		4		77	
3 „ „	12.8	4		27.5		16		107	

Date	Salinity of the pond-water S ‰	Mosquito-net catches				Emerged from larvae and pupae collected			
		Number of Anopheline ♀♀ per 10 M² and per night				Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles					
			average		average		total		total
4 V '19	12.8	4		22.5		—		—	
7 „ „	12.9	0		6		15		84	
26 „ „	15.0	0	26:13=	10	378:13=	7		107	
27 „ „	15.9	1	2	26	29	9	69	82	805
23 „ „	18.4	2.5		54		1		66	
21 „ „	19.1	0		36		5		70	
24 „ „	19.1	2.5		29		2		91	
25 „ „	19.3	1		35		—		—	
22 „ „	19.45	0		5		3		67	
17 XII '18	38.3	0	0:1= 0	280	280:1= 280	0	0	18	18
16 XII '18	40.7	0		443		—		—	
20 „ „	42.1	0		26		0		224	
20 XI „	42.2	—		—		0		10	
25 „ „	43.6	—	0:7=	—	1656:7=	0		24	
19 XII „	43.6	0	0	155	237	0	0	269	893
16 XI „	45.9	—		—		0		92	
15 XII „	46.4	0		244		—		—	
14 „ „	46.5	0		48		0		25	
13 „ „	46.9	0		564		0		76	
18 „ „	48.9	0		176		0		173	
21 XII '18	52.3	—		—		0		101	
12 „ „	54.8	0		301		0		205	
25 XI „	57.8	—	0:1=	—	301:1=	0		299	
23 „ „	58.4	—	0	—	301	0	0	54	790
22 „ „	58.9	—		—		0		116	
18 „ „	59.6	—		—		0		15	
15 XI '18	62.6	—		—		0	0	15	15

Ponds near Fluit (Djembatan Tomes).

Date	Salinity of the pond-water S ‰	Mosquito-net catches — Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia ludlowi Theobald		Mosquito-net catches — Myzomyia rossii Giles		Emerged from larvae and pupae collected — Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
31 III '19	3.7	0		16		16		70	
2 IV „	3.7	10		35		17		83	
3 „ „	3.8	9		47.5		62		109	
1 „ „	4.7	4	36.5 : 8=	25	303 : 8=	19		130	
30 III „	5.2	5	5	42.5	38	—	168	—	660
5 IV „	5.2	6		51		33		119	
6 „ „	5.2	0		40		—		—	
4 „ „	9.6	2.5		46		21		149	
7 IV '19	11.8	7.5		51		38		97	
28 III „	12.1	4		141		3		91	
29 „ „	12.95	2.5		66		3		118	
10 IV „	14.4	7.5		211		12		61	
21 VII „	15.3	16	37.5:11=	31	622.5:11=	8		31	
8 IV „	15.4	0	3	32.5	57	16	111	82	652
9 „ „	15.6	0		20		26		105	
11 „ „	15.9	0		29		0		28	
12 „ „	16.1	0		15		0		10	
13 „ „	16.6	0		10		—		—	
14 „ „	16.9	0		16		5		29	
12 IX '19	34.7	17		442		—		—	
5 „ „	36.1	5		62		—		—	
6 „ „	37.7	2		23		—		—	
7 „ „	37.9	10	142 : 9=	186	1809 : 9=	—		—	
8 „ „	38.7	39	16	333	201	—	—	—	—
13 „ „	38.7	3		130		—		—	
9 „ „	38.9	6		124		—		—	
10 „ „	39.1	33		132		—		—	
11 „ „	39.7	27		377		—		—	
14 IX '19	40.0	1		117		—		—	
15 „ „	40.0	1	2 : 5=	41	317 : 5=	—		—	
5 XII '18	44.6	0	0.4	60	63	1	1	170	343

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
11 XII '18	44.6	0		70		0		117	·
9 " "	49.8	0		29		0		56	
10 XII '18	54.1	0	0 : 1= 0	56	56 : 1= 56	—	—	—	—
7 XII '18	70.7	0	0 : 1= 0	51	51 : 1= 51	0	0	18	18
6 XII '18	84.6	0	0 : 1= 0	59	59 : 1= 59	0	0	146	146

Ponds near (Muara) Pegantungan.

Date	Salinity	M. ludlowi	average	M. rossii	average	M. ludlowi	total	M. rossii	total
23 IV '19	7.9	1	1 : 1= 1	25	25 : 1= 25	6	6	86	86
5 VII '19	10.5	4		14		34		73	
4 " "	10.6	4		22.5		54		66	
16 " "	11.2	55		64		8		2	
12 " "	11.9	10		22.5		31		71	
22 IV "	13.2	0		5		—		—	
21 " "	13.5	0		12.5		—		—	
11 VII "	13.5	17.5		40		25		28	
17 " "	14.3	142.5		80		49		25	
6 " "	14.7	9	370.5:20=	26	514:20=	—		—	
7 " "	14.8	25	19	35	26	21	337	51	587
20 IV "	14.9	0		7.5		4		73	
10 VII "	16.1	11		64		12		40	
14 " "	16.8	47.5		52.5		25		12	
13 " "	16.9	21		9		—		—	
19 IV "	18.1	0		14		2		23	
16 " "	18.2	0		2.5		1		18	
17 " "	18.2	0		6		3		15	
15 VII "	19.35	4		21		35		29	
18 IV "	19.5	0		10		1		50	
18 VII "	19.8	20		6		32		11	

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
8 VII '19	20.4	0		35		6		20	
15 IV ,,	21.5	0	58.5:4=	6	66:4=	0		21	
9 VII ,,	22.0	6	15	14	16.5	6	12	19	60
19 ,, ,,	22.2	52.5		11		—		—	
			2.5:1=		16:1=				
20 VII '19	29.25	2.5	2.5	16	16	—	—	—	—

Ponds near Pekulitan.

Date	Salinity of the pond-water S ‰	Myzomyia ludlowi Theobald	average	Myzomyia rossii Giles	average	Myzomyia ludlowi Theobald	total	Myzomyia rossii Giles	total
15 VI '19	4.0	22.5		27.5		—		—	
9 ,, ,,	4.2	6		5		—		—	
10 ,, ,,	4.8	12.5		34		40		29	
16 ,, ,,	4.8	45		45		43		11	
4 ,, ,,	5.1	0		7.5		8		5	
7 ,, ,,	5.4	2.5		11		39		15	
8 ,, ,,	5.4	50		82.5		—		—	
3 ,, ,,	5.6	9		14		16		27	
14 ,, ,,	5.7	21		16		—		—	
2 ,, ,,	5.75	19		56		25		20	
5 ,, ,,	5.9	6		22.5		15		16	
11 ,, ,,	5.9	16		26		63		42	
17 ,, ,,	6.2	31	881.5:31=	21	1422.5:31=	72		36	
23 III ,,	6.3	0	28	32.5	46	—	794	—	714
6 VI ,,	6.3	0		6		38		17	
18 ,, ,,	6.4	14		7.5		35		8	
12 ,, ,,	6.5	6		9		21		9	
13 ,, ,,	6.5	29		29		12		10	
22 III ,,	6.7	19		161		23		201	
19 VI ,,	7.1	16		16		21		12	
23 ,, ,,	8.0	29		26		70		30	
20 III ,,	8.1	2		27		5		52	
31 V ,,	8.2	16		95		45		49	
1 VI ,,	8.2	59		141		—		—	
20 ,, ,,	8.3	36		62.5		8		4	

Date	Salinity of the pond-water S ‰	Mosquito-net catches				Emerged from larvae and pupae collected			
		Number of Anopheline ♀♀ per 10 M² and per night				Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles					
			average		average		total		total
24 VI '19	8.35	151		76		74		13	
30 V „	8.7	25		87.5		—		—	
25 VI „	8.75	149		75		61		10	
29 V „	8.8	4		31		—		—	
28 „ „	9.0	10		90		19		85	
21 VI „	9.7	76		82.5		41		13	
22 VI '19	10.4	26		60		—		—	
28 „ „	12.0	269		50		—		—	
26 „ „	12.8	89		39		29		15	
27 „ „	12.8	140		39		45		17	
27 III „	13.2	5		55		1		51	
21 „ „	13.5	2,5	897 : 9=	61	441.5 : 9=	4		76	
1 VII „	13.7	—	100	—	49	—	179	—	207
2 „ „	14.0	84		42.5		31		10	
29 VI „	14.1	154		45		—		—	
3 VII „	15.5	127,5		50		69		38	
18 III „	18.7	—		—		—		—	
19 „ „	19.2	—		—		—		—	
24 III '19	22.0	0	0 : 2=	22.5	41.5 : 2=	1		85	
26 „ „	23.9	0	0	19	21	0	1	30	115
			0 : 1=		21 : 1=				
25 III '19	25.0	0	0	21	21	2	2	116	116
30 XI '18	36.2	4	4 : 4=	214	717 : 4=	0		112	
27 „ „	39.2	0	1	137	179	0	0	42	351
26 „ „	39.3	0		147		0		75	
28 „ „	39.3	0		219		0		122	
29 XI '18	40.0	1	1 : 4=	784	1636 : 4=	0		176	
3 XII „	41.3	0	0.25	181	409	1	1	71	341
2 „ „	47.6	0		176		0		94	
1 „ „	48.2	0		495		—		—	
			0 : 1=		23 : 1=				
4 XII '18	52.2	0	0	23	23	0	0	61	61

Ponds near Luar Batang.

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
30 III '19	7.15	19	19 : 1 = 19	117	117 : 1 = 117	—	—	—	—
29 III '19	11.5	27		170		7		46	
31 „ „	12.8	1		16		13		62	
3 IV „	12.9	9	45 : 5 =	143	459 : 5 =	5		66	
1 „ „	13.4	4	9	110	92	2	36	50	317
2 „ „	13.75	4		20		9		93	
18 III „	14.5	—		—		—		—	
19 „ „	15.6	—		—		—		—	
26 III '19	23.9	1		43		5		65	
27 „ „	23.9	3	14 : 4 =	19	202 : 4 =	10		121	
28 „ „	24.3	0	3.5	14	50.5	12	27	146	332
22 XII '18	24.6	10		126		—		—	
20 III '19	25.7	7		73		8		79	
21 „ „	26.5	6		170		5		25	
22 „ „	27.1	1		63		16		104	
12 XI '18	27.8	—	41 : 8 =	—	471 : 8 =	8		72	
25 III '19	28.2	0	5	29	59	—	62	—	613
24 „ „	28.3	0		20		9		132	
23 XII '18	28.3	6		50		3		112	
23 III '19	28.5	1		46		—		—	
24 XII '18	28.9	20		20		5		69	
11 XI „	29.2	—		—		8		20	
25 XII '18	30.25	—	—	—	—	—	—	—	—

Ponds near Jaagpad.

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
6 II '19	3.4	0		27		—		—	
3 VI „	4.2	13		58		14		20	
7 II „	4.25	0		115		—		—	
4 VI „	4.3	56		72		14		10	
16 II „	4.4	0		137.5		—		—	
5 VI „	5.6	23		63		7		25	
6 „ „	5.6	9		41		17		31	
19 II „	6.0	—		—		—		—	
15 „ „	6.4	0	101:13=	123	1184:13=	—		—	
17 „ „	7.5	0	8	113	91	—	52	—	86
15 „ „	8.2	0		227.5		—		—	
8 „ „	8.6	0		85		—		—	
17 „ „	8.6	0		67		—		—	
18 „ „	8.6	—		—		—		—	
16 „ „	8.7	0		55		—		—	
18 „ „	8.7	—		—		—		—	
20 „ „	8.8	—		—		—		—	
21 „ „	8.9	—		—		—		—	
19 „ „	9.1	—		—		—		—	
21 „ „	9.1	—		—		—		—	
10 II '19	10.1	7.5		35		—		—	
9 „ „	10.3	0		57		—		—	
„ „ „	10.3	—		—		—		—	
11 „ „	10.8	0		335		—		—	
10 „ „	10.9	15		242.5		—		—	
20 „ „	11.0	—		—		—		—	
8 „ „	11.1	0		123		—		—	
12 „ „	11.1	0		112.5		—		—	
11 „ „	11.3	10		43		—		—	
12 „ „	11.5	0		180		—		—	
13 „ „	11.7	0		155		—		—	
7 „ „	11.8	0	280.5:21=	55	2802.5 : 21=	—		—	
14 „ „	12.4	0	13	242.5	133	—	27	—	16
„ „ „	12.5	0		180		—		—	

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald	average	Myzomyia rossii Giles	average	Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald	total	Number of ♀♀ of Myzomyia rossii Giles	total
7 VI ’19	12.6	13		28		—		—	
5 II „	13.2	7		607		—		—	
13 „ „	13.2	5		45		—		—	
6 „ „	14.8	0		46		—		—	
9 VI „	18.1	29		48		—		—	
10 „ „	18.2	74		118		16		4	
11 „ „	18.9	103		105		3		6	
8 „ „	19.0	0		4		—		—	
12 „ „	19.4	17		41		8		6	
17 VI ’19	20.8	0		2		16		18	
20 „ „	20.8	36		30		9		4	
13 „ „	21.1	3		6		—		—	
22 „ „	21.4	55		41		—		—	
14 „ „	21.5	3		8		3		19	
21 „ „	22.3	33		29		30		51	
5 II „	22.7	7	244 : 14 =	383	714 : 14 =	—		—	
15 VI „	22.7	0	17	11	51	—	132	—	149
16 „ „	22.9	43		43		17		20	
2 „ „	23.4	8		30		4		1	
18 „ „	24.2	34		78		41		15	
1 II „	24.3	—		—		—		—	
19 VI „	24.3	16		20		12		21	
26 V „	24.45	1		6		—		—	
27 „ „	24.7	5		27		—		—	
6 IV ’19	25.9	7		57		—		—	
28 V „	25.9	5		51		—		—	
16 XII ’18	26.4	0		156		—		—	
4 IV ’19	26.4	29		236		11		66	
7 „ „	26.5	4		139		2		18	
23 V „	26.5	17		51		—		—	
1 VI „	26.7	18		108		—		—	
24 V „	26.8	120		126		—		—	
5 IV „	26.9	3		41		10		96	
8 „ „	27.1	6	450 : 21 =	270	2451 : 21 =	0		10	
9 „ „	27.5	6	21	147	117	5	146	6	358

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
25 V '19	27.5	15		32		—		—	
29 „ „	27.55	24		36		—		—	
10 IV „	28.15	49		120		9		21	
31 V „	28.35	57		167		102		55	
14 IV „	28.7	27		114		—		—	
30 V „	28.9	26		80		—		—	
11 IV „	28.95	19		247		6		70	
12 „ „	29.2	7		93		1		16	
13 „ „	29.7	7		40		—		—	
27 XII '18	29.8	4		140		—		—	
28 XII '18	30.2	10		76		6		112	
27 „ „	30.5	0		10		4		61	
29 „ „	30.7	31		269		—		—	
26 XI „	30.8	0		73		2		55	
27 „ „	31.1	0		187		0		172	
5 I '19	31.2	0		4		—		—	
30 XI '18	31.5	0		16		—		—	
1 II '19	31.9	—		—		—		—	
28 XI '18	32.0	7		492		3		199	
14 XII „	32.0	0		51		0		91	
17 „ „	32.2	—		—		0		160	
6 I '19	32.4	0		40		—		—	
30 XII '18	32.7	0	60 : 25 =	114	4837 : 25 =	0		20	
29 XI „	33.2	9	2	724	193	3	20	118	1144
31 XII „	33.5	0		2		—		—	
19 XI „	36.6	?		?		—		—	
2 I '19	37.4	0		8		0		14	
2 II „	37.4	0		93		—		—	
„ „ „	37.4	3		90		—		—	
3 I „	37.4	0		18		0		35	
31 XII '18	38.1	0		24		2		86	
3 I '19	38.1	0		60		0		21	
3 II „	38.5	0		1200		—		—	
15 XII '18	38.7	0		185		—		—	
7 I '19	38.7	0		164		—		—	

Date	Salinity of the pond-water S ‰	Mosquito-net catches				Emerged from larvae and pupae collected			
		Number of Anopheline ♀♀ per 10 M² and per night				Number of ♀♀ of		Number of ♀♀ of	
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Myzomyia ludlowi Theobald		Myzomyia rossii Giles	
			average		average		total		total
4 II '19	38.8	0		433		—		—	
3 ,, ,,	39.0	0		490		—		—	
2 I ,,	39.9	0		14		—		—	
4 II '19	40.1	0		132.5		—		—	
4 I ,,	40.7	0		76		—		—	
28 XII '18	42.4	0		86		—		—	
6 I '19	42.4	0	2 : 8 =	46	1293 : 8 =	—		—	
4 ,, ,,	42.8	2	0.25	202	162	—	0	—	116
30 XII '18	44.2	0		20		—		—	
19 XI ,,	47.0	—		—		0		40	
7 I '19	48.1	0		192.5		—		—	
25 XI '18	48.5	0		538		0		76	
16 XI '18	52.5	0		230(?)		—		—	
23 ,, ,,	54.6	0	0 : 4 =	315	1781 : 2 =	0		61	
21 ,, ,,	58.7	0	0	730(?)	890.5	0	0	87	148
24 ,, ,,	59 2	0		1466		—		—	
20 XI '18	60.1	0	0 : 3 =	581(?)	675 : 1 =	—		—	
22 ,, ,,	60.1	0	0	675	675	0	0	74	74
17 ,, ,,	65.1	0		165(?)		—		—	

Ponds near Heemraad.

Date	Salinity	ludlowi	average	rossii	average	Emerged ludlowi	total	Emerged rossii	total
24 VII '19	9.1	272.5	926 : 3 =	27.5	166.5 : 3 =	0		13	
25 ,, ,,	9.3	647.5	309	139	55.5	0	113	18	40
23 IV ,,	9.7	6		0		113		9	
22 IV '19	10.2	163		17		—		—	
25 ,, ,,	10.55	—		—		—		—	
24 ,, ,,	10.8	93		14		88		8	
20 ,, ,,	10.9	80		10		113		12	
21 ,, ,,	10.9	214		17		—		—	
18 ,, ,,	11.05	163		50		94		10	
26 ,, ,,	11.1	36		6		1		15	
16 ,, ,,	11.3	307		54		149		28	

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
17 IV '19	11.4	66		24		147		15	
19 " "	13.1	184		201		111		11	
15 " "	13.7	101		37		73		15	
23 VI "	14.4	2		0		40		20	
24 " "	15.8	5	2312:26=	2	583.5 : 26 =	54		12	
6 VII "	15.9	47	89	13	22	—	1098	—	288
7 " "	15.9	50		17		30		4	
25 VI "	16.0	11		9		—		—	
8 VII "	16.1	59		26		102		69	
26 VI "	16.2	17		5		—		—	
28 " "	16.6	46		7		10		15	
27 " "	16.8	9		0		25		8	
29 " "	16.8	7		2		—		—	
1 VII "	17.2	—		—		—		—	
2 " "	17.3	4		5		25		8	
3 " "	17.5	25		6		31		15	
5 " "	17.8	3		1		5		13	
4 " "	18.0	15		2		0		7	
23 " "	18.1	509		51		0		3	
31 " "	19.85	96		7.5		—		—	
22 VII '19	20.1	272.5		54		—		—	
3 VIII "	20.1	54		5		—		—	
4 " "	20.6	37.5		6		—		—	
2 " "	20.65	65		7.5		—		—	
1 " "	20.8	52.5		5		—		—	
5 " "	20.9	102.5	1162:12=	9	146 : 12 =	—		—	
6 " "	23.6	126	97	7.5	12	—	—	—	—
29 VII "	23.7	30		1		—		—	
26 " "	23.8	302		40		—		—	
27 " "	24.3	52.5		5		—		—	
7 VIII "	24.3	67.5		6		—		—	
8 " "	24.85	0		0		—		—	
28 VII '19	25.0	54	80 : 3=	9	10 : 3 =	0		22	
9 VIII "	25.2	26	27	1	3	—	0	—	22
30 VII "	26.1	0		0		—		—	

Ponds near Heemraad Oost.

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
11 VIII '19	4.8	24		2		—		—	
9 V ,,	8.6	107		17		110		11	
3 IX ,,	9.3	108	532:7=	6	133:7=	—		—	
4 ,, ,,	9.4	99	76	12	19	—	206	—	27
10 V ,,	9.8	152		17		96		16	
29 VIII ,,	9.9	38		7		—		—	
14 I ,,	9.9	4		72		—		—	
5 V '19	10.0	123		21		99		9	
13 ,, ,,	10.0	175		19		135		11	
21 ,, ,,	10.0	289		59		47		9	
12 VIII ,,	10.0	13		0		—		—	
7 V ,,	10.1	113		17		75		28	
8 ,, ,,	10.2	26		19		68		5	
11 ,, ,,	10.2	212		10		—		—	
16 ,, ,,	10.3	131		26		71		39	
18 ,, ,,	10.3	92		28		—		—	
19 ,, ,,	10.3	117		15		59		2	
13 VIII ,,	10.3	45		3		—		—	
30 ,, ,,	10.35	7		2		—		—	
31 ,, ,,	10.35	1		1		—		—	
1 IX ,,	10.35	2		2		—		—	
17 V ,,	10.4	107		59		38		14	
14 ,, ,,	10.5	91		34		63		14	
15 VIII ,,	10.5	30		2		—		—	
17 ,, ,,	10.5	45		5		—		—	
18 ,, ,,	10.5	74		7		—		—	
19 ,, ,,	10.6	75		4		—		—	
15 V ,,	10.7	87		45		112		50	
16 VIII ,,	10.7	50		7		—		—	
12 XI '18	10.8	—		—		13		77	
12 V '19	10.8	211		34		69		6	
20 ,, ,,	10.8	83		9		111		30	
14 VIII ,,	10.8	18		2		—		—	
20 ,, ,,	10.8	80		11		—		—	

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
24 VIII '19	10.8	203		16		—		—	
21 „ „	10.9	187		15		—		—	
28 „ „	11.0	144		8		—		—	
23 „ „	11.1	124		10		—		—	
6 V „	11.2	90		31		49		6	
22 VIII „	11.2	132		8		—		—	
25 „ „	11.4	94		6		—		—	
26 „ „	11.4	28		2		—		—	
27 „ „	11.4	112		11		—		—	
2 IX „	11.6	5		2		—		—	
27 IV „	11.9	34		3		—		—	
28 „ „	12.3	0		1		129		20	
1 V „	12.5	3		4		18		0	
29 IV „	12.6	43	4132:58=	1	1754:58=	53		11	
4 V „	12.7	57	71	14	30	—	1647	—	613
30 IV „	12.8	20		6		101		21	
10 VIII „	12.8	7		2		—		—	
13 XI '18	13.0	?		?		—		—	
„ „ „	13.1	167		208		41		75	
11 „ „	13.25	—		—		80		81	
19 XII „	13.5	—		—		—		—	
3 V '19	13.5	106		26		120		23	
16 I „	14.0	10		70		—		—	
2 V „	14.1	167		20		60		11	
31 I „	15.0	—		—		—		—	
18 „ „	15.1	28		58		—		—	
15 „ „	15.2	20		215		—		—	
17 „ „	16.2	0		25		—		—	
19 „ „	16.4	16		130		—		—	
8 „ „	16.6	0		0		—		—	
9 „ „	16.9	0		88		—		—	
20 „ „	17.9	8		30		—		—	
21 „ „	18.2	—		—		—		—	
10 XII '18	18.7	—		—		2		12	
10 I '19	18.7	5		40		—		—	
26 „ „	19.2	10		107		—		—	

Date	Salinity of the pond-water S ‰	Mosquito-net catches				Emerged from larvae and pupae collected			
		Number of Anopheline ♀♀ per 10 M² and per night				Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		Myzomyia ludlowi Theobald		Myzomyia rossii Giles					
			average		average		total		total
7 XII '18	19.2	1		6		34		59	
11 I '19	19.9	14		150		—		—	
9 XII '18	20.0	0		4		35		42	
22 I '19	20.1	24		148		—		—	
24 " "	20.2	7		27		—		—	
12 " "	20.3	—		—		—		—	
18 XII '18	20.8	—		—		—		—	
23 I '19	21.7	—		—		—		—	
27 " "	21.8	—		—		—		—	
30 XII '18	22.5	—	147:7=	—	666:7=	—		—	
28 I '19	22.75	7	21	30	95	—	52	—	147
20 XII '18	23.0	—		—		—		—	
19 " "	23.1	—		—		—		—	
21 " "	23.3	—		—		—		—	
25 I '19	23.9	10		73		—		—	
8 XII '18	24.0	1		13		—		—	
13 " "	24.2	98		371		17		105	
30 I '19	24.65	—		—		—		—	
22 XII '18	24.9	—		—		—		—	
15 XI '18	25.0	(87)		(17288)		7		121	
14 I '19	25.1	5		252.5		—		—	
23 XII '18	25.2	—		—		—		—	
11 " "	25.8	57		241		21		78	
2 " "	26.05	0		178		2		147	
4 " "	26.2	2		20		12		55	
29 I '19	26.7	—		—		—		—	
12 XII '18	26.9	293		1037		58		222	
16 I '19	27.0	15		217,5		—		—	
1 XII '18	27.2	6	468.5:19=	345	4186.5:19=	—		—	
18 I '19	27.4	10	25	300	220	—	179	—	850
19 " "	27.5	2		14		—		—	
17 " "	27.85	20		340		—		—	
15 " "	27.9	15		90		—		—	
31 " "	28.1	2.5		27.5		—		—	

Date	Salinity of the pond-water S ‰	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			average		average		total		total
20 I '19	28.4	8		304		—		—	
6 XII '18	28.45	2.5		257		24		85	
21 I '19	28.5	8		186		—		—	
22 ,, ,,	28.6	7.5		125		—		—	
3 XII '18	28.7	0		44		55		142	
23 I '19	29.3	8		124		—		—	
24 ,, ,,	29.9	8		84		—		—	
25 I '19	30.0	12		106		—		—	
27 ,, ,,	30.0	7.5		37.5		—		—	
26 ,, ,,	30.3	15		130		—		—	
29 ,, ,,	30.7	5		37.5		—		—	
28 ,, ,,	30.8	—		—		—		—	
5 XII '18	31.5	50	103.5 : 9 =	500	1409 : 9 =	0		21	
30 I '19	32.6	—	11.5	—	157	—	0	—	50
10 ,, ,,	32.7	7.5		87.5		—		—	
9 ,, ,,	33.6	2.5		122.5		—		—	
12 ,, ,,	34.4	—		—		—		—	
11 ,, ,,	34.85	0		274		—		—	
13 XI '18	35.3	—		—		0		29	
8 I '19	38.1	4		114		—		—	
14 XI '18	40.7	—	—	—	—	0	0	36	36

Ponds near Antjol.

			average		average		total		total
22 V '19	20.3	7	7 : 1 = 7	0	0 : 1 = 0	87	87	9	9
18 XI '18	44.0	—	—	—	—	0	0	74	74

TABLE VI.

Topographically and chronologically arranged data concerning salinities and Anophelines, collected in the Batavia sea fish-ponds in 1918 and 1919; with monthly averages of the salinities and of the mosquito-net catches per 10 M² and per night and monthly totals of the Anopheline ♀♀ emerged from the larvae and pupae collected.

Ponds near Muara Karang.

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
15 XI '18	62.6		—		—		0		15	
16 ,, ,,	45.9		—		—		0		92	
18 ,, ,,	59.6		—		—		0		15	
20 ,, ,,	42.2		—		—		0		10	
22 ,, ,,	58.9	53.6 ‰	—	—	—	—	0	0	116	625
23 ,, ,,	58.4		—		—		0		54	
25 ,, ,,	57.8		—		—		0		299	
,, ,, ,,	43.6		—		—		0		24	
12 XII '18	54.8		0		301		0		205	
13 ,, ,,	46.9		0		564		0		76	
14 ,, ,,	46.5		0		48		0		25	
15 ,, ,,	46.4		0		244		—		—	
16 ,, ,,	40.7		0	0:9=	443	2237:9=	—		—	
17 ,, ,,	38.3	46.0 ‰	0	0	280	249	0	0	18	1091
18 ,, ,,	48.9		0		176		0		173	
19 ,, ,,	43.6		0		155		0		269	
20 ,, ,,	42.1		0		26		0		224	
21 ,, ,,	52.3		—		—		0		101	
24 IV '19	8.4		4		99		5		70	
25 ,, ,,	8.15		7.5		69		48		7	
26 ,, ,,	8.4		0	17.5:7=	57.5	336.5:7=	6		51	
27 ,, ,,	8.8	9.0 ‰	0	2.5	39	48	—	74	—	218
28 ,, ,,	8.55		0		9		5		48	
29 ,, ,,	8.6		0		9		10		42	
30 ,, ,,	11.8		6		54		—		—	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
1 V '19	12.6		5		44		7		54	
2 ,, ,,	12.7		0		29		4		77	
3 ,, ,,	12.8		4		27.5		16		107	
4 ,, ,,	12.8		4		22.5		—		—	
5 ,, ,,	5.5		0		12.5		12		33	
6 ,, ,,	9.7		12.5		30		41		77	
7 ,, ,,	12.9		0		6		15		84	
8 ,, ,,	4.7		0		15		3		50	
9 ,, ,,	4.2		0		12.5		2		71	
10 ,, ,,	4.35		0		24		9		107	
11 ,, ,,	3.95		0	41:27 =	30	688.5 : 27 =	—		—	
12 ,, ,,	4.4	10.5 ‰	6	2	24	25.5	4	175	100	1711
13 ,, ,,	4.8		0		6		2		62	
14 ,, ,,	6.1		0		29		11		157	
15 ,, ,,	7.45		2.5		89		7		67	
16 ,, ,,	8.5		0		9		1		29	
17 ,, ,,	6.7		0		41		5		52	
18 ,, ,,	8.4		0		12.5		—		—	
19 ,, ,,	5.45		0		12.5		5		42	
20 ,, ,,	8.5		0		17.5		4		59	
21 ,, ,,	19.1		0		36		5		70	
22 ,, ,,	19.45		0		5		3		67	
23 ,, ,,	18.4		2.5		54		1		66	
24 ,, ,,	19.1		2.5		29		2		91	
25 ,, ,,	19.3		1		35		—		—	
26 ,, ,,	15.0		0		10		7		107	
27 ,, ,,	15.9		1		26		9		82	

Ponds near Fluit (Djembatan Tomes).

Date	Salinity S ‰	monthly average	M. ludlowi	monthly average	M. rossii	monthly average	M. ludlowi emerged	monthly total	M. rossii emerged	monthly total
5 XII '18	44.6		0		60		1		170	
6 ,, ,,	84.6		0		59		0		146	
7 ,, ,,	70.7		0	0 : 6 =	51	325 : 6 =	0		18	
9 ,, ,,	49.8	58.1 ‰	0	0	29	54	0	1	56	507
10 ,, ,,	54.1		0		56		—		—	
11 ,, ,,	44.6		0		70		0		117	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline per ♀♀ 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
28 III '19	12.1		4		141		3		91	
29 „ „	12.95		2.5	11.5 : 4 =	66	265.5 : 4 =	3		118	
30 „ „	5.2	8.5 ‰	5	3	42.5	66	—	22	—	279
31 „ „	3.7		0		16		16		70	
1 IV '19	4.7		4		25		19		130	
2 „ „	3.7		10		35		17		83	
3 „ „	3.8		9		47.5		62		109	
4 „ „	9.6		2.5		46		21		149	
5 „ „	5.2		6		51		33		119	
6 „ „	5.2		0		40		—		—	
7 „ „	11.8		7.5	46.5 : 14 =	51	629 : 14 =	38		97	
8 „ „	15.4	11.1 ‰	0	3	32.5	45	16	249	82	1002
9 „ „	15.6		0		20		26		105	
10 „ „	14.4		7.5		211		12		61	
11 „ „	15.9		0		29		0		28	
12 „ „	16.1		0		15		0		10	
13 „ „	16.6		0		10		—		—	
14 „ „	16.9		0		16		5		29	
				16 : 1 =		31 : 1 =				
21 VII '19	15.3	15.3 ‰	16	16	31	31	8	8	31	31
5 IX '19	36.1		5		62		—		—	
6 „ „	37.7		2		23		—		—	
7 „ „	37.9		10		186		—		—	
8 „ „	38.7		39		333		—		—	
9 „ „	38.9		6		124		—		—	
10 „ „	39.1		33		132		—		—	
11 „ „	39.7		27	144 : 11 =	377	1967 : 11 =	—		—	
12 „ „	34.7	38.3 ‰	17	13	442	179	—	—	—	—
13 „ „	38.7		3		130		—		—	
14 „ „	40.0		1		117		—		—	
15 „ „	40.0		1		41		—		—	

Ponds near (Muara) Pegantungan.

Date	Salinity of the pond-water S ‰	monthly average	Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald	monthly average	Myzomyia rossii Giles	monthly average	Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald	monthly total	Number of ♀♀ of Myzomyia rossii Giles	monthly total
15 IV '19	21.5		0		6		0		21	
16 „ „	18.2		0		2.5		1		18	
17 „ „	18.2		0		6		3		15	
18 „ „	19.5		0	1 : 9 =	10	88.5 : 9 =	1		50	
19 „ „	18.1	16.1 ‰	0	0.1	14	10	2	17	23	286
20 „ „	14.9		0		7.5		4		73	
21 „ „	13.5		0		12.5		—		—	
22 „ „	13.2		0		5		—		—	
23 „ „	7.9		1		25		6		86	
4 VII '19	10.6		4		22.5		54		66	
5 „ „	10.5		4		14		34		73	
6 „ „	14.7		9		26		—		—	
7 „ „	14.8		25		35		21		51	
8 „ „	20.4		0		35		6		20	
9 „ „	22.0		6		14		6		19	
10 „ „	16.1		11		64		12		40	
11 „ „	13.5		17.5	431.5 : 17 =	40	532.5 : 17 =	25		28	
12 „ „	11.9	16.7 ‰	10	25	22.5	31	31	338	71	447
13 „ „	16.9		21		9		—		—	
14 „ „	16.8		47.5		52.5		25		12	
15 „ „	19.35		4		21		35		29	
16 „ „	11.2		55		64		8		2	
17 „ „	14.3		142.5		80		49		25	
18 „ „	19.8		20		6		32		11	
19 „ „	22.2		52.5		11		—		—	
20 „ „	29.25		2.5		16		—		—	

Ponds near Pekulitan.

Date	Salinity S ‰	monthly average	Myzomyia ludlowi	monthly average	Myzomyia rossii	monthly average	Emerged ludlowi	monthly total	Emerged rossii	monthly total
26 XI '18	39.3		0		147		0		75	
27 „ „	39.2		0	5 : 5 =	137	1501 : 5 =	0		42	
28 „ „	39.3	38.8 ‰	0	1	219	300	0	0	122	527
29 „ „	40.0		1		784		0		176	
30 „ „	36.2		4		214		0		112	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
1 XII '18	48.2		0		495		—		—	
2 „ „	47.6		0	0 : 4 =	176	875 : 4 =	0		94	
3 „ „	41.3	47.3 ‰	0	0	181	219	1	1	71	226
4 „ „	52.2		0		23		0		61	
18 III '19	18.7		—		—		—		—	
19 „ „	19.2		—		—		—		—	
20 „ „	8.1		2		27		5		52	
21 „ „	13.5		2.5		61		4		76	
22 „ „	6.7		19	28.5 : 8 =	161	399 : 8 =	23		201	
23 „ „	6.3	15.7 ‰	0	4	32.5	50	—	36	—	611
24 „ „	22.0		0		22.5		1		85	
25 „ „	25.0		0		21		2		116	
26 „ „	23.9		0		19		0		30	
27 „ „	13.2		5		55		1		51	
28 V '19	9.0		10		90		19		85	
29 „ „	8.8		4	55 : 4 =	31	303.5 : 4 =	—		—	
30 „ „	8.7	8.7 ‰	25	14	87.5	76	—	64	—	134
31 „ „	8.2		16		95		45		49	
1 VI '19	8.2		59		141		—		—	
2 „ „	5.75		19		56		25		20	
3 „ „	5.6		9		14		16		27	
4 „ „	5.1		0		7.5		8		5	
5 „ „	5.9		6		22.5		15		16	
6 „ „	6.3		0		6		38		17	
7 „ „	5.4		2.5		11		39		15	
8 „ „	5.4		50		82.5		—		—	
9 „ „	4.2		6		5		—		—	
10 „ „	4.8		12.5		34		40		29	
11 „ „	5.9		16		26		63		42	
12 „ „	6.5		6		9		21		9	
13 „ „	6.5		29		29		12		10	
14 „ „	5.7		21		16		—		—	
15 „ „	4.0		22.5		27.5		—		—	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M^2 and per night				Emerged from larvae and pupae collected			
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
16 VI '19	4.8		45	1483.5 : 29=	45	1131.5 : 29=	43		11	
17 „ „	6.2	7.4 ‰	31	51	21	39	72	776	36	359
18 „ „	6.4		14		7.5		35		8	
19 „ „	7.1		16		16		21		12	
20 „ „	8.3		36		62.5		8		4	
21 „ „	9.7		76		82.5		41		13	
22 „ „	10.4		26		60		—		—	
23 „ „	8.0		29		26		70		30	
24 „ „	8.35		151		76		74		13	
25 „ „	8.75		149		75		61		10	
26 „ „	12.8		89		39		29		15	
27 „ „	12.8		140		39		45		17	
28 „ „	12.0		269		50		—		—	
29 „ „	14.1		154		45		—		—	
1 VII '19	13.7		—	211.5 : 2=	—	92.5 : 2=	—		—	
2 „ „	14.0	14.4 ‰	84	106	42.5	46	31	100	10	48
3 „ „	15.5		127.5		50		69		38	

Ponds near Luar Batang.

Date	Salinity	monthly average	Myzomyia ludlowi	monthly average	Myzomyia rossii	monthly average	Emerged ludlowi	monthly total	Emerged rossii	monthly total
11 XI '18	29.2	28.5 ‰	—	—	—	—	8	16	20	92
12 „ „	27.8		—		—		8		72	
22 XII '18	24.6		10		126		—		—	
23 „ „	28.3		6	36 : 3=	50	196 : 3=	3		112	
24 „ „	28.9	28.0 ‰	20	12	20	65	5	8	69	181
25 „ „	30.25		—		—		—		—	
18 III '19	14,5		—		—		—		—	
19 „ „	15.6		—		—		—		—	
20 „ „	25.7		7		73		8		79	
21 „ „	26.5		6		170		5		25	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
22 III '19	27.1		1		63		16		104	
23 „ „	28.5		1		46		—		—	
24 „ „	28.3		0	66 : 12 =	20	780 : 12 =	9		132	
25 „ „	28.2	21.3 ‰	0	5.5	29	65	—	85	—	780
26 „ „	23.9		1		43		5		65	
27 „ „	23.9		3		19		10		121	
28 „ „	24.3		0		14		12		146	
29 „ „	11.5		27		170		7		46	
30 „ „	7.15		19		117		—		—	
31 „ „	12 8		1		16		13		62	
1 IV '19	13.4		4	17 : 3 =	110	273 : 3 =	2		50	
2 „ „	13.75	13.35 ‰	4	6	20	91	9	16	93	209
3 „ „	12.9		9		143		5		66	

Ponds near Jaagpad.

Date	Salinity	monthly average	M. ludlowi	monthly average	M. rossii	monthly average	Emerged M. ludlowi	monthly total	Emerged M. rossii	monthly total
16 XI '18	52.5		?		?		—		—	
17 „ „	65.1		?		?		—		—	
19 „ „	47.0		—		—		0		40	
„ „ „	36.6		?		?		—		—	
20 „ „	60.1		?		?		—		—	
21 „ „	58.7		?		?		0		87	
22 „ „	60.1		0	16 : 9 =	675	4486 : 9 =	0		74	
23 „ „	54.6	46.7 ‰	0	2	315	498	0	8	61	882
24 „ „	59.2		0		1466		—		—	
25 „ „	48.5		0		538		0		76	
26 „ „	30.8		0		73		2		55	
27 „ „	31.1		0		187		0		172	
28 „ „	32.0		7		492		3		199	
29 „ „	33.2		9		724		3		118	
30 „ „	31.5		0		16		—		—	

Date	Salinity of the pond-water S ⁰/₀₀		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
14 XII '18	32.0		0		51		0		91	
15 » »	38.7		0		185		—		—	
16 » »	26.4		0		156		—		—	
17 » »	32.2		—		—		0		160	
27 » »	30.5		0		10		4		61	
» » »	29.8		4	45 : 12 =	140	1133 : 12 =	—		—	
28 » »	42.4	33.9 ⁰/₀₀	0	4	86	94	—	12	—	530
» » »	30.2		10		76		6		112	
29 » »	30.7		31		269		—		—	
30 » »	32.7		0		114		0		20	
» » »	44.2		0		20		—		—	
31 » »	33.5		0		2		—		—	
» » »	38.1		0		24		2		86	
2 I '19	37.4		0		8		0		14	
» » »	39.9		0		14		0		68	
3 » »	37.4		0		18		0		35	
» » »	38.1		0		60		0		21	
4 » »	42.8		2		202		—		—	
» » »	40.7		0	2 : 11 =	76	824.5 : 11 =	—		—	
5 » »	31.2	39.0 ⁰/₀₀	0	0.2	4	75	—	0	—	138
6 » »	42.4		0		46		—		—	
» » »	32.4		0		40		—		—	
7 » »	38.7		0		164		—		—	
» » »	48.1		0		192.5		—		—	
1 II '19	24.3		—		—		—		—	
» » »	31.9		—		—		—		—	
2 » »	37.4		0		93		—		—	
» » »	37.4		3	3 : 6 =	90	2488.5 : 6 =	—		—	
3 » »	39.0	35.9 ⁰/₀₀	0	0.5	490	406	—		—	
» » »	38.5		0		1200		—		—	
4 » »	38.8		0		433		—		—	
» » »	40.1		0		132.5		—		—	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
5 II '19	22.7		7	14:2=	383	990:2=	—		—	
" " "	13.2	17.95‰	7	7	607	495	—	—	—	—
6 " "	14.8		0		46		—		—	
" " "	3.4		0		27		—		—	
7 " "	4.25		0		115		—		—	
" " "	11.8		0		55		—		—	
8 " "	11.1		0		123		—		—	
" " "	8.6		0		85		—		—	
9 " "	10.3		0		57		—		—	
" " "	10.3		—		—		—		—	
10 " "	10.9		15		242.5		—		—	
" " "	10.1		7.5		35		—		—	
11 " "	11.3		10		43		—		—	
" " "	10.8		0		335		—		—	
12 " "	11.5		0		180		—		—	
" " "	11.1		0	37.5:23=	112.5	2801.5:23=	—		—	
13 " "	13.2	9.5‰	5	2	45	122	—	—	—	—
" " "	11.7		0		155		—		—	
14 " "	12.5		0		180		—		—	
" " "	12.4		0		242.5		—		—	
15 " "	8.2		0		227.5		—		—	
" " "	6.4		0		123		—		—	
16 " "	8.7		0		55		—		—	
" " "	4.4		0		137.5		—		—	
17 " "	8.6		0		67		—		—	
" " "	7.5		0		113		—		—	
18 " "	8.7		—		—		—		—	
" " "	8.6		—		—		—		—	
19 " "	6.0		—		—		—		—	
" " "	9.1		—		—		—		—	
20 " "	8.8		—		—		—		—	
" " "	11.0		—		—		—		—	
21 " "	8.9		—		—		—		—	
" " "	9.1		—		—		—		—	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
4 IV '19	26.4		29		236		11		66	
5 „ „	26.9		3		41		10		96	
6 „ „	25.9		7		57		—		—	
7 „ „	26.5		4		139		2		18	
8 „ „	27.1		6	164 : 11 =	270	1504 : 11 =	0		10	
9 „ „	27.5	27.7 ‰	6	15	147	137	5	44	6	303
10 „ „	28.15		49		120		9		21	
11 „ „	28.95		19		247		6		70	
12 „ „	29.2		7		93		1		16	
13 „ „	29.7		7		40		—		—	
14 „ „	28.7		27		114		—		—	
23 V '19	26.5		17		51		—		—	
24 „ „	26.8		120		126		—		—	
25 „ „	27.5		15		32		—		—	
26 „ „	24.45		1		6		—		—	
27 „ „	24.7		5		27		—		—	
28 „ „	25.9		5	270 : 9 =	51	576 : 9 =	—		—	
29 „ „	27.55	26.7 ‰	24	30	36	64	—	102	—	55
30 „ „	28.9		26		80		—		—	
31 „ „	28.35		57		167		102		55	
1 VI '19	26.7		18		108		—		—	
2 „ „	23.4		8		30		4		1	
3 „ „	4.2		13		58		14		20	
4 „ „	4.3		56		72		14		10	
5 „ „	5.6		23		63		7		25	
6 „ „	5.6		9		41		17		31	
7 „ „	12.6		13		28		—		—	
8 „ „	19.0		0		4		—		—	
9 „ „	18.1		29		48		—		—	
10 „ „	18.2		74	586 : 22 =	118	984 : 22 =	16		4	
11 „ „	18.9	18.1 ‰	103	27	105	45	3	211	6	251
12 „ „	19.4		17		41		8		6	
13 „ „	21.1		3		6		—		—	
14 „ „	21.5		3		8		3		19	

Date	Salinity of the pond-water S $^0/_{00}$		Mosquito-net catches				Emerged from larvae and pupae collected			
			Number of Anopheline ♀♀ per 10 M^2 and per night				Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles					
		monthly average		monthly average		monthly average		monthly total		monthly total
15 VI '19	22.7		0		11		—		—	
16 „ „	22.9		43		43		17		20	
17 „ „	20.8		0		2		16		18	
18 „ „	24.2		34		78		41		15	
19 „ „	24.3		16		20		12		21	
20 „ „	20.8		36		30		9		4	
21 „ „	22.3		33		29		30		51	
22 „ „	21.4		55		41		—		—	

Ponds near Heemraad.

Date	Salinity	monthly average		monthly average		monthly average		monthly total		monthly total
15 IV '19	13.7		101		37		73		15	
16 „ „	11.3		307		54		149		28	
17 „ „	11.4		66		24		147		15	
18 „ „	11.05		163		50		94		10	
19 „ „	13.1		184		201		111		11	
20 „ „	10.9		80	1413:11=	10	430:11=	113		12	
21 „ „	10.9	11.3 $^0/_{00}$	214	128	17	39	—	889	—	123
22 „ „	10.2		163		17		—		—	
23 „ „	9.7		6		0		113		9	
24 „ „	10.8		93		14		88		8	
25 „ „	10.55		—		—		—		—	
26 „ „	11.1		36		6		1		15	
23 VI '19	14.4		2		0		40		20	
24 „ „	15.8		5		2		54		12	
25 „ „	16.0		11	97:7=	9	25:7=	—		—	
26 „ „	16.2	16.1 $^0/_{00}$	17	14	5	4	—	129	—	55
27 „ „	16.8		9		0		25		8	
28 „ „	16.6		46		7		10		15	
29 „ „	16.8		7		2		—		—	
1 VII '19	17.2		—		—		—		—	
2 „ „	17.3		4		5		25		8	
3 „ „	17.5		25		6		31		15	
4 „ „	18.0		15		2		0		7	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia ludlowi Theobald		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
5 VII '19	17.8		3		1		5		13	
6 „ „	15.9		47		13		—		—	
7 „ „	15.9		50		17		30		4	
8 „ „	16.1		59		26		102		69	
22 „ „	20.1		272.5		54		—		—	
23 „ „	18.1		509		51		0		3	
24 „ „	9.1		272.5	2439 : 17 =	27.5	404 : 17 =	0		13	
25 „ „	9.3	18.6 ‰	647.5	143	139	24	0	193	18	172
26 „ „	23.8		302		40		—		—	
27 „ „	24.3		52.5		5		—		—	
28 „ „	25.0		54		9		0		22	
29 „ „	23.7		30		1		—		—	
30 „ „	26.1		0		0		—		—	
31 „ „	19.85		96		7.5		—		—	
1 VIII '19	20.8		52.5		5		—		—	
2 „ „	20.65		65		7.5		—		—	
3 „ „	20.1		54		5		—		—	
4 „ „	20.6		37.5	531 : 9 =	6	47 : 9 =	—		—	
5 „ „	20.9	22.3 ‰	102.5	59	9	5	—	—	—	—
6 „ „	23.6		126		7.5		—		—	
7 „ „	24.3		67.5		6		—		—	
8 „ „	24.85		0		0		—		—	
9 „ „	25.2		26		1		—		—	

Ponds near Heemraad Oost.

Date	Salinity S ‰	monthly average	Myzomyia ludlowi	monthly average	Myzomyia rossii	monthly average	♀♀ M. ludlowi	monthly total	♀♀ M. rossii	monthly total
11 XI '18	13.25		—		—		80		81	
12 „ „	10.8		—		—		13		77	
13 „ „	35.3		—	167 : 1 =	—	208 : 1 =	0		29	
„ „ „	13.1	21.6 ‰	167	167	208	208	41	141	75	419
„ „ „	13.0		?		?		—		—	
14 „ „	40.7		—		—		0		36	
15 „ „	25.0		(87)		(17288)		7		121	

Date	Salinity of the pond-water S ‰		Mosquito-net catches. Number of Anopheline ♀♀ per 10 M² and per night: Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected. Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
1 XII '18	27.2		6		345		—		—	
2 „ „	26.05		0		178		2		147	
3 „ „	28.7		0		44		55		142	
4 „ „	26.2		2		20		12		55	
5 „ „	31 5		50		500		0		21	
6 „ „	28.45		2.5		257		24		85	
7 „ „	19.2		1		6		34		59	
8 „ „	24.0		1		13		—		—	
9 „ „	20.0		0		4		35		42	
10 „ „	18.7		—	509.5:12=	—	3016 : 12=	2		12	
11 „ „	25.8	24.0 ‰	57	42	241	251	21	260	78	968
12 „ „	26.9		293		1037		58		222	
13 „ „	24.2		98		371		17		105	
18 „ „	20.8		—		—		—		—	
19 „ „	23.1		—		—		—		—	
„ „ „	13.5		—		—		—		—	
20 „ „	23.0		—		—		—		—	
21 „ „	23.3		—		—		—		—	
22 „ „	24.9		—		—		—		—	
23 „ „	25.2		—		—		—		—	
30 „ „	22.5		—		—		—		—	
8 I '19	38.1		4		114		—		—	
8 „ „	16.6		0		0		—		—	
9 „ „	33.6		2.5		122.5		—		—	
„ „ „	16.9		0		88		—		—	
10 „ „	32,7		7.5		87.5		—		—	
„ „ „	18.7		5		40		—		—	
11 „ „	34.85		0		274		—		—	
„ „ „	19.9		14		150		—		—	
12 „ „	34,4		—		—		—		—	
„ „ „	20.3		—		—		—		—	
14 „ „	25.1		5		252.5		—		—	
„ „ „	9.9		4		72		—		—	
15 „ „	27.9		15		90		—		—	
„ „ „	15,2		20		215		—		—	
16 „ „	27.0		15		217.5		—		—	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
16 I '19	14.0		10		70		—		—	
17 „ „	27.85		20		340		—		—	
„ „ „	16.2		0		25		—		—	
18 „ „	27.4		10	325.5:36=	300	4236.5:36=	—		—	
„ „ „	15.1	24.2 ‰	28	9	58	118	—	—	—	—
19 „ „	16.4		16		130		—		—	
„ „ „	27.5		2		14		—		—	
20 „ „	28.4		8		304		—		—	
„ „ „	17.9		8		30		—		—	
21 „ „	28.5		8		186		—		—	
„ „ „	18.2		—		—		—		—	
22 „ „	28.6		7.5		125		—		—	
„ „ „	20.1		24		148		—		—	
23 „ „	29.3		8		124		—		—	
„ „ „	21.7		—		—		—		—	
24 „ „	29.9		8		84		—		—	
„ „ „	20.2		7		27		—		—	
25 „ „	30.0		12		106		—		—	
„ „ „	23.9		10		73		—		—	
26 „ „	30.3		15		130		—		—	
„ „ „	19.2		10		107		—		—	
27 „ „	30.0		7.5		37.5		—		—	
„ „ „	21.8		—		—		—		—	
28 „ „	30.8		—		—		—		—	
„ „ „	22.75		7		30		—		—	
29 „ „	30.7		5		37.5		—		—	
„ „ „	26.7		—		—		—		—	
30 „ „	24.65		—		—		—		—	
„ „ „	32.6		—		—		—		—	
31 „ „	28.1		2.5		27.5		—		—	
„ „ „	15.0		—		—		—		—	
27 IV '19	11.9		34		3		—		—	
28 „ „	12.3		0	97:4=	1	11:4=	129		20	
29 „ „	12.6	12.4 ‰	43	24	1	3	53	283	11	52
30 „ „	12.8		20		6		101		21	

Date	Salinity of the pond-water S ‰		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night — Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Emerged from larvae and pupae collected: Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
1 V '19	12.5		3		4		18		0	
2 „ „	14.1		167		20		60		11	
3 „ „	13.5		106		26		120		23	
4 „ „	12.7		57		14		—		—	
5 „ „	10.0		123		21		99		9	
6 „ „	11.2		90		31		49		6	
7 „ „	10.1		113		17		75		28	
8 „ „	10.2		26		19		68		5	
9 „ „	8.6		107		17		110		11	
10 „ „	9.8		152	2539 : 21 =	17	524 : 21 =	96		16	
11 „ „	10.2	10.8 ‰	212	121	10	25	—	1400	—	284
12 „ „	10.8		211		34		69		6	
13 „ „	10.0		175		19		135		11	
14 „ „	10.5		91		34		63		14	
15 „ „	10.7		87		45		112		50	
16 „ „	10.3		131		26		71		39	
17 „ „	10.4		107		59		38		14	
18 „ „	10.3		92		28		—		—	
19 „ „	10.3		117		15		59		2	
20 „ „	10.8		83		9		111		30	
21 „ „	10.0		289		59		47		9	
10 VIII '19	12.8		7		2		—		—	
11 „ „	4.8		24		2		—		—	
12 „ „	10.0		13		0		—		—	
13 „ „	10.3		45		3		—		—	
14 „ „	10.8		18		2		—		—	
15 „ „	10.5		30		2		—		—	
16 „ „	10.7		50		7		—		—	
17 „ „	10.5		45		5		—		—	
18 „ „	10.5		74		7		—		—	
19 „ „	10.6		75		4		—		—	
20 „ „	10.8		80	1531 : 22 =	11	131 : 22 =	—		—	
21 „ „	10.9	10.55 ‰	187	70	15	6	—	—	—	—
22 „ „	11.2		132		8		—		—	
23 „ „	11.1		124		10		—		—	

Date	Salinity of the pond-water S ⁰/₀₀		Mosquito-net catches: Number of Anopheline ♀♀ per 10 M² and per night				Emerged from larvae and pupae collected			
			Myzomyia ludlowi Theobald		Myzomyia rossii Giles		Number of ♀♀ of Myzomyia ludlowi Theobald		Number of ♀♀ of Myzomyia rossii Giles	
		monthly average		monthly average		monthly average		monthly total		monthly total
24 VIII '19	10.8		203		16		—		—	
25 „ „	11.4		94		6		—		—	
26 „ „	11.4		28		2		—		—	
27 „ „	11.4		112		11		—		—	
28 „ „	11.0		144		8		—		—	
29 „ „	9.9		38		7		—		—	
30 „ „	10.35		7		2		—		—	
31 „ „	10.35		1		1		—		—	
1 IX '19	10.35	10.2 ⁰/₀₀	2	214 : 4 = 53.5	2	22 : 4 = 5.5	—	—	—	—
2 „ „	11.6		5		2		—		—	
3 „ „	9.3		108		6		—		—	
4 „ „	9.4		99		12		—		—	

Ponds near Antjol.

Date	Salinity	monthly average	Myzomyia ludlowi	monthly average	Myzomyia rossii	monthly average	♀♀ ludlowi	monthly total	♀♀ rossii	monthly total
18 XI '18	44.0	44.0 ⁰/₀₀	—	—	—	—	0	0	74	74
22 V '19	20.3	20.3 ⁰/₀₀	7	7 : 1 = 7	0	0 : 1 = 0	87	87	9	9

TABLE VII A.

Average number of ♀♀ o

	0 — 9.9 ‰			10 — 19.9 ‰			20 — 24.9 ‰		
	Aggregate number of *ludlowi* ♀♀ captured per 10 M² and per night in *n* times	Number *of times the* mosquito-nets were set = *n*	Average *number of* ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average *number of* ludlowi ♀♀ captured per 10 M² and per night	Aggregate *number of* ludlowi ♀♀ captured per 10 M² and per night in *n* times	*Number* of times the mosquito-nets were set = *n*	*Average* number of ludlowi ♀♀ captured per 10 M² and per night
Muara Karang	$32^{1}/_{2}$:	21 =	2	26 :	13 =	2	—	—	—
Fluit (Djembatan Tomes).	$36^{1}/_{2}$:	8 =	5	$37^{1}/_{2}$:	11 =	3	—	—	—
(Muara) Pegantungan . .	1 :	1 =	1	$370^{1}/_{2}$:	20 =	19	$58^{1}/_{2}$:	4 =	15
Pekulitan	$881^{1}/_{2}$:	31 =	28	*897* :	9 =	*100*	0 :	2 =	0
Luar Batang	19 :	1 =	19	45 :	5 =	9	14 :	4 =	$3^{1}/_{2}$
Jaagpad	101 :	13 =	8	$280^{1}/_{2}$:	21 =	13	44 :	14 =	17
Heemraad	*926* [1]) :	3 =	*309*	*2312* :	26 =	*89*	*1162* :	*12* =	*97*
Heemraad Oost	*532* :	7 =	*76*	*4132* :	58 =	*71*	147 :	7 =	*21*
…tjol	—	—	—	—	—	—	7 :	1 =	7
…erages for the whole of Batavia empang-region	$2529^{1}/_{2}$: 85 = 29		448 : 8 = *56*	$8100^{1}/_{2}$: *163* = *50*		*306 : 8* = $38^{1}/_{4}$	*16*$32^{1}/_{2}$: 44 = 37		$170^{1}/_{2}$: 7 = $24^{1}/_{2}$

[1]) The figures in italics denote a ludlowi-production that was greater than the corresponding rossii-production (cf. Table VII B).

Average number of ♀♀ of *Myzomyia ludlowi* THEOBALD captured by means of mosquito-nets per 10 M² and per night at

20 — 24.9 ‰			25 — 29.9 ‰			30 — 39.9 ‰			40 — 49.9 ‰		
ggregate ımber of dlowi ♀♀ ptured per) M² and ɔer night *n times*	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night *in n times*	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number c ludlowi ♀ captured p 10 M² an per nigh
—	—	—	—	—	—	0 :	1 =	0	0 :	7 =	0
—	—	—	—	—	—	142 :	9 =	16	2 (40 ‰) :	5 =	1/2
58½ :	4 =	15	2½ :	1 =	2½	—	—	—	—	—	—
0 :	2 =	0	0 :	1 =	0	4 :	4 =	1	1 (40 ‰) :	4 =	1/4
14 :	4 =	3½	41 :	8 =	5	—	—	—	—	—	—
44 :	14 =	17	450 :	21 =	21	60 :	25 =	2	2 (42.8 ‰) :	8 =	1/4
1162 :	12 =	*97*	*80* :	3 =	*27*	—	—	—	—	—	—
147 :	7 =	21	468½ :	19 =	25	103½ :	9 =	11½	—	—	—
? :	? =	?	—	—	—	—	—	—	—	—	—
1632½ : 44 = 37		170½ : 7 = 24½	1042 : 53 = 20		80½ : 6 = 13½	309½ : 48 = 6		30½ : 5 = 6	5 : 24 = 1/5		1 : ‹ = 1/

oduction (cf. Table VII B).

different salinities.

	50—59.9 ‰			60—69.9 ‰			70—79.9 ‰			80—89.9 ‰		
...of ... ♀♀ ...d per ...d ...t	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of ludlowi ♀♀ captured per 10 M² and per night	Aggregate number of ludlowi ♀♀ captured per 10 M² and per night in *n* times	Number of times the mosquito-nets were set = *n*	Avera... numbe... ludlow... capture... 10 M²... per ni...
	0 :	1 =	0	—	—	—	—	—	—	—	—	—
	0 :	1 =	0	—	—	—	0 :	1 =	0	0 (84,6 ‰) :	1 =	0
	—	—	—	—	—	—	—	—	—	—	—	—
	0 :	1 =	0	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
	0 :	4 =	0	0 :	3 =	0	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
	7		0 : 4	0 :	3	0 : 1	0 :	1	0 : 1	0 :	1	0 :
	= 0		= 0	= 0		= 0	= 0		= 0	= 0		= 0

TABLE VII B.

	0 — 9.9 ‰			10 — 19.9 ‰		
	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in n times	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in n times	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night
Muara Karang	647 :	21 =	31	378 :	13 =	29
Fluit (Djembatan Tomes).	303 :	8 =	38	622½ :	11 =	57
(Muara) Pegantungan . .	25 :	1 =	25	514 :	20 =	26
Pekulitan	1422½ :	31 =	46	441½ :	9 =	49
Luar Batang	117 :	1 =	117	459 :	5 =	92
Jaagpad	1184 :	13 =	91	2802½ :	21 =	133
Heemraad	166½ :	3 =	55½	583½ :	26 =	22
Heemraad Oost	133 :	7 =	19	1754 :	58 =	30
Antjol	—	—	—	—	—	—
Averages for the whole of the Batavia empang-region	3998 : 85 = 47		422½ : 8 = 53	7555 : 163 = 46		438 : 8 = 55

Average number of ♀♀ of *Myzomyia rossii* GILES captured by means of mosquito-nets per 10 M^2 and per night at different s

	20 — 24.9 ‰		25 — 29.9 ‰			30 — 39.9 ‰			40 — 49.9 ‰			
.te of ♀♀ per .nd .ht nes	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in n times	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in n times	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in n times	Number of times the mosquito-nets were set = n	Average number of rossii ♀♀ captured per 10 M^2 and per night	Agg num ros capt 10 per in
	—	—	—	—	—	280 :	1 =	280	1656 :	7 =	237	
	—	—	—	—	—	1809 :	9 =	201	317 :	5 =	63	
6 :	4 =	$16^{1}/_{2}$	16 :	1 =	16	—	—	—	—	—	—	
$1^{1}/_{2}$:	2 =	21	21 :	1 =	21	717 :	4 =	179	1636 :	4 =	409	
2 :	4 =	$50^{1}/_{2}$	471 :	8 =	59	—	—	—	—	—	—	
4 :	14 =	51	2451 :	21 =	117	4837 :	25 =	193	1293 :	8 =	162	
6 :	12 =	12	10 :	3 =	3	—	—	—	—	—	—	
6 :	7 —	95	$4186^{1}/_{2}$:	19 =	220	1409 :	9 =	157	—	—	—	
0 :	1 =	0	—	—	—	—	—	—	—	—	—	
$5^{1}/_{2}$:	44	246 : 7	$7155^{1}/_{2}$:	53	436 : 6	9052 :	48	1010 : 5	4902 :	24	871 : 4	
= 42		= 35	= 135		= 73	= 189		= 202	= 204		= 218	

salinities.

50 — 59.9 ‰			60 — 69.9 ‰			70 — 79.9 ‰			80 — 89.9 ‰		
gregate ber of ssii ♀♀ ured per M^2 and night *n* times	Number of times the mosquito-nets were set = *n*	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of rossii ♀♀ captured per 10 M^2 and per night	Aggregate number of rossii ♀♀ captured per 10 M^2 and per night in *n* times	Number of times the mosquito-nets were set = *n*	Average number of rossii ♀♀ captured per 10 M^2 and per night
301 :	1 =	301	—	—	—	—	—	—	—	—	—
56 :	1 =	56	—	—	—	51 :	1 =	51	59 (84,6‰) :	1 =	59
—	—	—	—	—	—	—	—	—	—	—	—
23 :	1 =	23	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
781 :	2 =	890½	675 :	1 =	675	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
161 : 5 = 432		1270½ : 4 = 317½	675 : 1 = 675		675 : 1 = 675	51 : 1 = 51		51 : 1 = 51	59 : 1 = 59		59 : 1 = 59

Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ♀♀ of *Myzomyia ross*

	0 — 9.9 ‰		10 — 19.9 ‰		20 — 24.9 ‰		25 — 29.9 ‰	
	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emer larv pupae
. . .	32.5/647 = 5	180/1124 = 16	26/378 = 7	69/805 = 9	—	—	—	
omes) .	36.5/303 = 12	168/660 = 25	37.5/622.5 = 6	111/652 = 17	—	—	—	
an . .	1/25 = 4	6/86 = 7	370.5/514 = 72	337/587 = 57	58.5/66 = 89	12/60 = 20	2.5/16 = 15	
. . .	881.5/1422.5 = 62	794/714 = *111*	897/441.5 = *203*	179/207 = 86	0/41.5 = 0	1/115 = 0.9	0/21 = 0	2/116
. . .	19/117 = 16	—	45/459 = 10	36/317 = 11	14/202 = 7	27/332 = 8	41/471 = 9	62/613
. . .	101/1184 = 9	52/86 = 60	280.5/2802.5 = 10	27/16 = *169*	244/714 = 34	132/149 = 88	450/2451 = 18	146/358
. . .	926/166.5 = *556* [1])	113/40 = *282.5*	2312/583.5 = *396*	1098/288 = *381*	1162/146 = *796*	—	80/10 = *800*	0/22
. . .	532/133 = *400*	206/27 = *763*	4132/1754 = *236*	1647/613 = *269*	147/666 = 22	52/147 = 35	468.5/4186.5 = 11	179/850
. . .	—	—	—	—	7/0 = ∞	87/9 = *967*	—	
ng zone.	2529.5/3998 = 63	1519/2737 = 55	8100.5/7555 = *107*	3504/3485 = *101*	1632.5/1835.5 = 89	311/812 = 38	1042/7155.5 = 15	389/1959

talics denote a ludlowi-production that was greater than the corresponding rossii-production.

...different salinities. Mosquito-net catches and imagines emerged from larvae and pupae collected.

30 — 39.9 ‰		40 — 49.9 ‰		50 — 59.9 ‰		60 — 69.9 ‰		
...squito-net ...tches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mo...
= 0	$\frac{0}{18} = 0$	$\frac{0}{1656} = 0$	$\frac{0}{893} = 0$	$\frac{0}{301} = 0$	$\frac{0}{790} = 0$	—	$\frac{0}{15} = 0$	
= 8	—	$\frac{2}{317} = 0.5$ (40.0‰)	$\frac{1}{343} = 0.3$ (44.6‰)	$\frac{0}{56} = 0$	—	—	—	$\frac{0}{51...}$
—	—	—	—	—	—	—	—	
= 0.5	$\frac{0}{351} = 0$	$\frac{1}{1636} = 0.05$ (40.0‰)	$\frac{1}{341} = 0.3$ (41.3‰)	$\frac{0}{23} = 0$	$\frac{0}{61} = 0$	—	—	
—	—	—	—	—	—	—	—	
= 1	$\frac{20}{1144} = 2$	$\frac{2}{1293} = 0.2$ (42.8‰)	$\frac{0}{116} = 0$	$\frac{0}{1781} = 0$	$\frac{0}{148} = 0$	$\frac{0}{675} = 0$	$\frac{0}{74} = 0$	
—	—	—	—	—	—	—	—	
= 7	$\frac{0}{50} = 0$	—	$\frac{0}{36} = 0$	—	—	—	—	
—	—	—	$\frac{0}{74} = 0$	—	—	—	—	
= 3.5	$\frac{20}{1563} = 1.25$	$\frac{5}{4902} = 0.1$	$\frac{2}{1803} = 0.1$	$\frac{0}{2161} = 0$	$\frac{0}{999} = 0$	$\frac{0}{675} = 0$	$\frac{0}{89} = 0$	$\frac{0}{5...}$

pupae collected.

.9 ‰	60 — 69.9 ‰		70 — 79.9 ‰		80 — 89.9 ‰	
Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emer lar pupae
$\frac{0}{790} = 0$	—	$\frac{0}{15} = 0$	—	—	—	
—	—	—	$\frac{0}{51} = 0$	$\frac{0}{18} = 0$	$\frac{0}{59} = 0$	$\frac{0}{146}$
—	—	—	—	—	—	
$\frac{0}{61} = 0$	—	—	—	—	—	
—	—	—	—	—	—	
$\frac{0}{148} = 0$	$\frac{0}{675} = 0$	$\frac{0}{74} = 0$	—	—	—	
—	—	—	—	—	—	
—	—	—	—	—	—	
—	—	—	—	—	—	
$\frac{0}{999} = 0$	$\frac{0}{675} = 0$	$\frac{0}{89} = 0$	$\frac{0}{51} = 0$	$\frac{0}{18} = 0$	$\frac{0}{59} = 0$	$\frac{0}{146}$

LE X.

Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ...

	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosq... ca...
	—	625	2231	1091	—	—	—	—
(Djembatan Tomes).	—	—	$\frac{0}{325} = 0$	$\frac{1}{507} = 0.2$	—	—	—	—
ra) Pegantungan . .	—	—	—	—	—	—	—	—
itan	$\frac{5}{1501} = 0.3$	$\frac{0}{527} = 0$	$\frac{0}{875} = 0$	$\frac{1}{226} = 0.5$	—	—	—	—
Batang	—	$\frac{16}{92} = 17$	$\frac{36}{196} = 18$	$\frac{8}{181} = 4$	—	—	—	—
ad	$\frac{16}{4486} = 0.4$	$\frac{8}{882} = 0.9$	$\frac{45}{1133} = 4$	$\frac{12}{530} = 2$	$\frac{2}{824.5} = 0.25$	$\frac{0}{138} = 0$	$\frac{3}{2438.5} = 0.125$	—
raad	—	—	—	—	—	—	—	—
raad Oost	$\frac{167}{208} = 80$	$\frac{141}{419} = 34$	$\frac{509.5}{3016} = 17$	$\frac{260}{968} = 27$	$\frac{325,5}{4236,5} = 8$	—	—	—
l	—	$\frac{0}{74} = 0$	—	—	—	—	—	—

per 100 ♀♀ of *Myzomyia rossii* GILES in different months. Mosquito-net catches and imagines emerged from larvae and pupae

February 1919	Last 23 days of February 1919		March 1919		April 1919		May 1919		
Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches
—	—	—	—	—	$\frac{17.5}{336.5} = 5$	$\frac{74}{218} = 34$	$\frac{41}{688.5} = 6$	$\frac{175}{1711} = 10$	—
—	—	—	$\frac{11.5}{265.5} = 4$	$\frac{22}{279} = 8$	$\frac{46.5}{629} = 7$	$\frac{249}{1002} = 25$	—	—	—
—	—	—	—	—	$\frac{1}{88.5} = 1$	$\frac{17}{286} = 6$	—	—	—
—	—	—	$\frac{28.5}{399} = 7$	$\frac{36}{611} = 6$	—	—	$\frac{55}{303.5} = 18$	$\frac{64}{134} = 48$	$\frac{1483.5}{1131.5} =$
—	—	—	$\frac{66}{780} = 8$	$\frac{85}{780} = 11$	$\frac{17}{273} = 6$	$\frac{16}{209} = 8$	—	—	—
—	$\frac{37.5}{2801.5} = 1.5$	—	—	—	$\frac{164}{1504} = 11$	$\frac{44}{303} = 14$	$\frac{270}{576} = 47$	$\frac{102}{55} = \mathit{185}$	$\frac{586}{984} =$
—	—	—	—	—	$\frac{1413}{430} = \mathit{328}$[1]	$\frac{889}{123} = \mathit{723}$	—	—	$\frac{97}{25} =$
—	—	—	—	—	$\frac{97}{11} = \mathit{882}$	$\frac{283}{52} = \mathit{544}$	$\frac{2539}{524} = \mathit{484}$	$\frac{1400}{284} = \mathit{493}$	—
—	—	—	—	—	—	—	$\frac{7}{0} = \infty$	$\frac{87}{9} = \mathit{967}$	—

[1]) *The figures in italics denote a ludlowi-production that* w

from larvae and pupae collected.

…ay 1919		June 1919		July 1919		August 1919		September 1919	
…et	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected	Mosquito-net catches	Emerged from larvae and pupae collected
6	$\frac{175}{1711} = 10$	—	—	—	—	—	—	—	—
	—	—	—	$\frac{16}{31} = 0.5$	$\frac{8}{31} = 0.25$	—	—	$\frac{144}{1967} = 7$	—
	—	—	—	$\frac{431.5}{532.5} = 81$	$\frac{338}{447} = 76$	—	—	—	—
[illegible]	$\frac{64}{134} = \mathit{48}$	$\frac{1483.5}{1131.5} = \mathit{131}$	$\frac{776}{359} = \mathit{216}$	$\frac{211.5}{92.5} = \mathit{229}$	$\frac{100}{48} = \mathit{208}$	—	—	—	—
	—	—	—	—	—	—	—	—	—
7	$\frac{102}{55} = \mathit{185}$	$\frac{586}{984} = 60$	$\frac{211}{251} = 84$	—	—	—	—	—	—
	—	$\frac{97}{25} = \mathit{388}$	$\frac{129}{55} = \mathit{234}$	$\frac{2439}{404} = \mathit{604}$	$\frac{193}{172} = \mathit{112}$	$\frac{531}{47} = \mathit{1130}$	—	—	—
34	$\frac{1400}{284} = \mathit{493}$	—	—	—	—	$\frac{1531}{131} = \mathit{1169}$	—	$\frac{214}{22} = \mathit{973}$	—
0	$\frac{87}{9} = \mathit{967}$	—	—	—	—	—	—	—	—

…te a ludlowi-production that was greater than the corresponding rossii-production.

TABLE XI.

Averages and other resultant figures concerning salinities and Anophelines, derived from the Tables VII A, VII B and IX and relating to the entire Batavia empang zone.

	0-9.9‰	10-19.9‰	20-24.9‰	25-29.9‰	30-39.9‰	40-49.9‰	50-59.9‰	60-69.9‰	70-79.9‰	80-89.9‰
A	29	50	37	20	6	0.2	0	0	0	0
a	**56**	**38.25**	**24.5**	**13.5**	**6**	**0.25**	**0**	**0**	**0**	**0**
A B	63	107	89	15	3.5	0.1	0	0	0	0
A′ B′	55	101	(38)	20	1.25	0.1	0	0	0	0
B	47	46	42	135	189	204	432	675	51	59
b	**53**	**55**	**35**	**73**	**202**	**218**	**317.5**	**675**	**51**	**59**

A = Average number of ♀♀ of *Myzomyia ludlowi* THEOBALD captured, by means of mosquito-nets, per 10 M^2 and per night at different salinities. For each salinity class the averages are derived at once from all the data collected throughout the entire Batavia empang zone.

a = Average number of ♀♀ of *Myzomyia ludlowi* THEOBALD captured, by means of mosquito-nets, per 10 M^2 and per night at different salinities. The averages were obtained by determining for each salinity class the average of the local averages calculated for the different parts of the Batavia empang zone.

A B = Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ♀♀ of *Myzomyia rossii* GILES at different salinities. For each salinity class these numbers are derived at once from the total numbers of both Anophelines captured by means of mosquito-nets throughout the entire Batavia empang zone.

A′ B′ = Number of ♀♀ of *Myzomyia ludlowi* THEOBALD per 100 ♀♀ of *Myzomyia rossii* GILES at different salinities. For each salinity class these numbers are derived at once from the total numbers of both Anophelines emerged from larvae and pupae collected throughout the entire Batavia empang zone.

B = Averages relating to the production of *Myzomyia rossii* GILES which serve for comparison with the corresponding figures concerning the production of *Myzomyia ludlowi* THEOBALD mentioned after A.

b = Averages relating to the production of *Myzomyia rossii* GILES which serve for comparison with the corresponding figures concerning the production of *Myzomyia ludlowi* THEOBALD mentioned after a.

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