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Autor: Lewis, D.J.
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Scientific Staff, Medical Research Council, London.

Chironomidae as a Pest in the Northern Sudan.

By D. J. LEWIS
formerly Entomologist, Sudan Ministry of Health.

A few years ago the Chironomidae or non-biting midges were briefly mentioned as harmless insects in books on medical entomology. In some parts of the world, however, they cause much annoyance and interfere with human activities when they appear in vast numbers. The following are some examples, and others are referred to by the authors mentioned.

DE MEILLON and GRAY (1937, and 1938 in Annual Report of South African Institute for Medical Research) reported that Chironomidae were an intolerable pest at Port Elizabeth in South Africa. In this instance and in several of those mentioned below water-pollution was believed to be responsible. The annoying lake-fly of Lake Victoria is a mixture of Chironomidae and Chaoborinae (Culicidae) according to MACDONALD (1953). A small Chironomid is said to be annoying near Cairo in the summer and has been observed in immense numbers at Madi, chiefly in March and April on days when the south wind was blowing. KAMAL (1938) reported that Chironomidae from the Nile are very annoying in Egypt in April and May. WESENBERG-LUND (1951) stated that Chironomidae drive horses frantic in Denmark, and THIENEMANN (1954) gave some other examples of annoyance by these insects in Europe. Chironomidae are sometimes troublesome near sewage works (BUSVINE, 1951), lakes and reservoirs in the British Isles. Nuisance from Chironomidae in the United States of America has been recorded by BONNEL and MOTE (1951), FELLTON (1940), GERRY (1954), JOHNSON (1929), JOHNSON and MUNGER (1930) and MALLIS (1954).

Allergic troubles, which are believed to be largely due to Chironomidae in parts of the Sudan, can be caused by various insects. Some examples were given by BRAY and HURST (1934), KERN (1938), MATHESON (1950), MUNROE (1951) and ORDMAN (1946), and BOWEN (1951) referred to the considerable literature on the subject. The insects concerned include May-flies, Caddis flies and a species of the Chironomid genus *Tanytarsus*. BOWEN mentioned this midge which was reported, in 1938, to have caused hay-fever near a dam in Alabama. The condition of the three patients was improved by injection therapy.

In certain parts of the northern Sudan Chironomidae are a serious pest under conditions which make control extremely difficult.

The places mainly affected are the northern part of Khartoum and the town of Wadi Halfa where immense numbers of the midges cause intense annoyance in the early months of the year. They are generally believed to be responsible for much asthma and other allergic conditions because these are prevalent in the infested areas during the Chironomid season and people obtain relief by leaving the areas. The Chironomid pest in the Sudan differs from some of those in other countries in its severity and the fact that the flies emerge, not from small polluted lakes, but from a large unpolluted river.

It has not been possible to conduct continuous observations on the Chironomidae, but this paper comprises a general account of the problem. It is based on official reports, accounts by various residents, and personal observations. Early reports of Chironomidae have been sought in vain in books by the many travellers who visited the Sudan between 1820 and 1910 and recorded notes on other insects. These writers provide negative evidence which is valuable in elucidating the history of the problem.

Possible causes of the outbreaks are discussed in a tentative manner though a full investigation has not been made. This would involve prolonged specialized work on the hydrology and hydrobiology of the Nile at several places and is not at present justified by the problem, important though it is. Discussion at this stage may seem premature, but it may be of some use as an introduction to any future study of Chironomids in the Sudan, particularly because there is little information about this family in the literature of medical entomology.

Several previous publications have dealt with Chironomidae in the Sudan. KIEFFER (1921, 1922, 1923) recorded 68 species and two varieties from the White Nile, including *Nilodorum brevibucca* which is common at Khartoum. The Chironomid fauna was unknown and he described all the forms as new. KIEFFER (1924) repeated some of his earlier records and described several of the species now known at Khartoum. FREEMAN (1950) described *Tanytarsus lewisi,* a small species which is one of the most troublesome at Khartoum and Wadi Halfa; and GRINDLEY (1952) analysed the fat of Khartoum midges. LEWIS and others (1954) found that wind had an important effect in driving Chironomidae into the northern residential area of Khartoum, and LEWIS (1955) wrote a semi-popular account of Chironomidae and some other small flies in the Sudan. Some notes on Chironomidae in the annual reports of the Sudan Medical Service are mentioned later. The first annual report of the Hydrobiological Research Unit of the University College of Khartoum (1954) has already provided much valuable in-

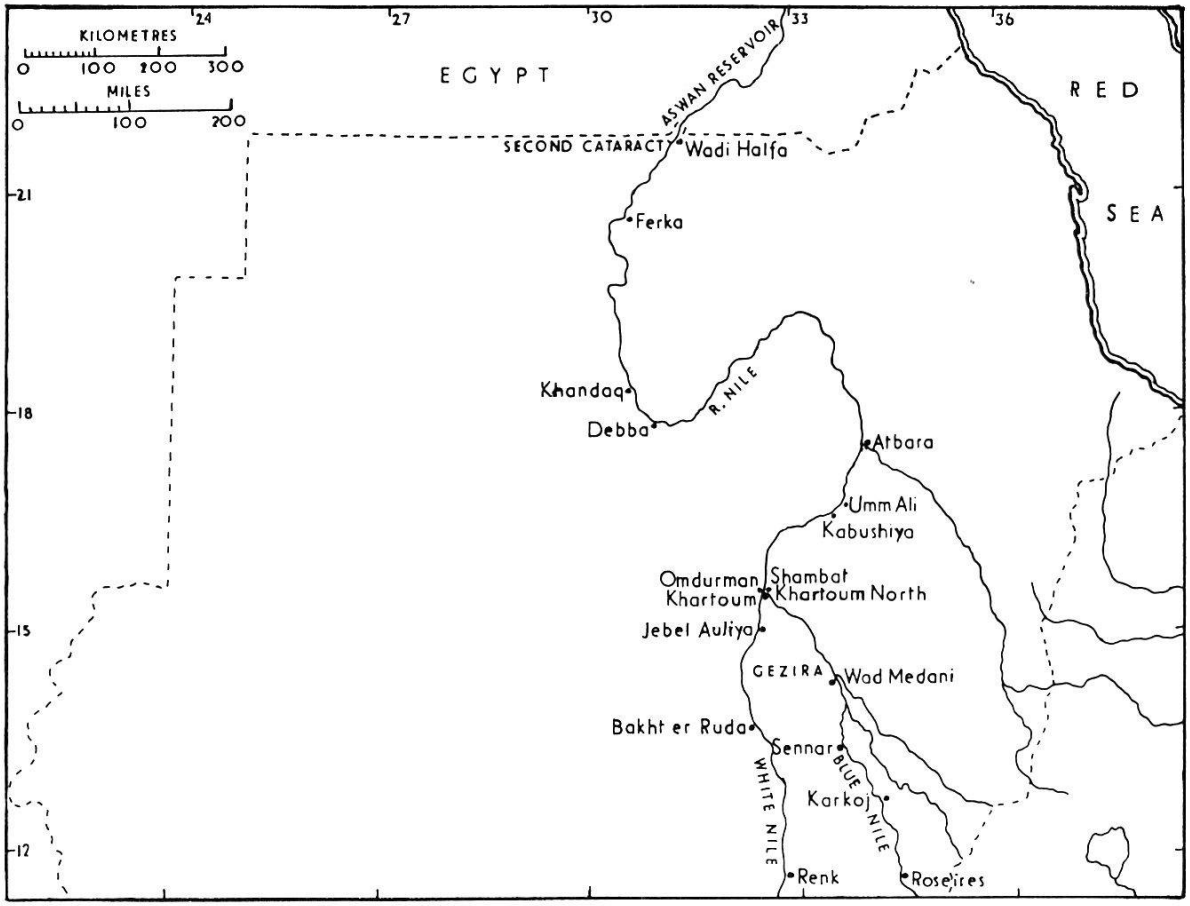

Fig. 1. The Sudan showing places mentioned in the text.

formation on the hydrobiology of the Nile, and it outlines work which is in progress. A description by the author of detailed studies on Chironomidae and preventive measures at Khartoum is in preparation. For the future it is suggested that, apart from any research work, records of "good" and "bad" Chironomid years could usefully be kept, particularly when the Roseires dam and the Aswan high dam are built.

Some Observations on Prevalence and Outbreaks of Chironomidae in Riverain Areas.

Much of the trouble caused by Chironomidae has passed unrecorded, and some of the observations noted in this section were made simply because an interested person happened to be present. Nevertheless the available records give a useful history of the problem.

Initials in brackets are those of some of the persons mentioned in the section on acknowledgements.

The White Nile.

There have been complaints of Chironomidae from Bakht er Ruda and Jebel Auliya from time to time.

The Blue Nile above Khartoum.

Tanytarsus lewisi is always found near the river at Wad Medani from about February to April sometimes in sufficient numbers to cause annoyance. In February 1951 a related species was common, and in March *T. lewisi* was again predominant. At the Gezira Research Farm, which is separated from the river by open country, people complain of Chironomidae and hay-fever about four times a year when there is a strong wind. The year 1953 was said to be the worst at Wad Medani for at least 18 years.

The red larvae of a species of *Chironomus,* found in a domestic water jar at Wad Medani, have been received for identification. Such larvae are found in various parts of the country and probably originated in wells.

Khartoum.

The mention of a particular year at Khartoum usually refers to the early months in which Chironomidae are prevalent.

1903 to 1925. No nuisance from Chironomidae mentioned by former residents who have been consulted.

1904. BALFOUR (1904) reported that bronchial asthma seemed to be unknown in the Sudan.

1909. LONGSTAFF (1911) recorded that small flies were annoying near lights on some evenings in February when the north wind was not too strong. LONGSTAFF (1912) again mentioned these flies, which seem likely to have been Chironomidae, and remarked that there were many gardens along the river. Gardens provide shelter for Chironomidae, but evidently did not cause the problem.

1918. In April the Commanding Officer of the Xth Sudanese Battalion of the Egyptian Army, stationed at Omdurman, submitted for identification insects about the size of *Phlebotomus* which had been taken while swarming round lights. The correspondence contains a note that they were probably Chironomidae, and the size suggests that they were possibly *Tanytarsus.*

1927. Chironomidae were troublesome (I. A.).

1928 and 1929. Chironomidae had become such a pest that an entomologist was engaged on preliminary studies to ascertain the cause of the outbreaks. The Sennar dam had recently been completed and was suspected of being responsible (R. C. M.-D.). It has no fish-ladder and it was thought that interference with the spawning migration of fish might have reduced the number of those which prey on Chironomid larvae.

1931. Some trees were cut down near the Gordon Memorial College (now the University College of Khartoum) in an attempt to prevent asthma (A. A. B.). In the nineteen-twenties there had been complaints of asthma which was thought to be due to *labakh* trees (*Acacia lebbek* Benth.) growing near the river (G. W. G.).

1932 to 1935. No records.

1937. Experiments with light traps against *Tanytarsus* this year and towards the end of 1936 were mentioned in annual reports of the Sudan Medical Service for 1936 and 1937.

1938. According to the report for this year the experiments were continued but it was concluded that control along these lines would be very expensive.

1939 to 1955. Chironomidae troublesome for varying periods in most years, beginning in the previous November or December or in January and ending in April or earlier.

1942. Bad in February (J. R.).

1943. Chironomidae reported to be undermining health.

1944. Season ending by 7th April.

1945. Midges noticed as abundant on 17th and 18th March by the writer during a visit to Khartoum.

1948. An exceptionally bad year. Many on 13th January. Some residents considered that Chironomidae had been worse since about 1940 than previously.

1950. Chironomidae not very troublesome.

1951. Not a bad year (LEWIS and others, 1954) although there had been a small outbreak in the previous December.

1952. Midges abundant on many days till April (LEWIS and others, 1954). The Sudan Medical Service Annual Report mentioned "strong circumstantial evidence that these insects are a common cause of hay fever, asthma and other allergic complaints".

1953. Several bad evenings in January but season exceptionally short.

1954. Light-trap catches indicated many bad evenings between mid-November 1953 and mid-March 1954. Many in February.

1954. Moderately bad. During recent years several valuable river-front houses had become offices partly owing to the Chironomid pest.

It now appears that the following are among the reasons why Chironomidae are a pest at Khartoum. The ovaries in *Tanytarsus* develop during the pupal stage so that the females can probably lay eggs soon after emerging. This must be an advantage to the midges in the warm and very dry climate which shortens the adult life. At the same time the warmth no doubt speeds larval growth and the increase of the population. Many *Tanytarsus* larvae and pupae float among the plankton at night and so are carried from up-river by the current. The northerly wind which prevails in the dry season blows the midges to the town where, owing to the semi-desert nature of the country, many houses are situated near the river bank among trees and shrubs which shelter the midges. Owing to the early sunsets and warm climate at this latitude people are out of doors or in open rooms in the early evening, and so are exposed to the effect of the midges. The adult flies are so small that they can enter any lighted room which is not tightly closed.

Khartoum North.

River-side houses in this town, which lies opposite Khartoum across the Blue Nile, are affected by Chironomidae but much less than at Khartoum because, except on calm days, most of them are blown across the river to Khartoum.

Omdurman.

Chironomidae have been troublesome since about 1948 at some houses with trees near the river. Allergic affects were soon noticed and some trees have been cut down.

Between Omdurman and Wadi Halfa.

There are few records from this long stretch of the Nile.

Chironomidae are common and hay-fever prevalent in the winter at Shambat.

Chironomidae were found to be abundant on the river bank at Kabushiya and Umm Ali in April 1955 (H. B.).

T. lewisi and caddis flies were troublesome at Atbara in April 1950, particularly at houses near the river.

A species of *Polypedylum* has been found at Khandaq in January and a *Tanytarsus* at Debba in the same month (C. M.).

Some pupal skins and adults of *T. lewisi* were found at Ferka on 16. 1. 51.

Wadi Halfa.

Wadi Halfa is on the junction of the railway from Khartoum and the steamer route to Egypt. It is a long narrow town below the Second Cataract and north of it is a long straight reach of Nile from which the Chironomidae are probably blown. Wadi Halfa will be submerged if the proposed high dam is built at Aswan, but a new Chironomid problem may arise upstream.

1938 to 1946. Chironomidae common usually for 15 or 30 days at river-side houses. The severity of the pest is emphasised by a telegram sent by the District Commissioner to the Governor of the Northern Province, suggesting that some travellers from the Sudan to Egypt and Europe should change from the Nile to the Red Sea route. It reads: "Request publication notice asthma subjects avoid Halfa reach for present stop you have seen serious consequences of midge plague here apparently considered exaggerated outside stop special camp for asthma patients started at aerodrome may require funds please recommend Dawa [Director of Medical Services] for assistance".

1938. Midges noticed towards the end of April when they infested the town by day and night. Considerable annoyance caused on 4th May, after two days of N.-N.-W. wind, and from 21st to 25th. Midges then gradually disappeared but were again bad from 8th to 13th June. Inhabitants said this was the first outbreak known in the town and attributed it to the raising of the Aswan reservoir.

1939. From 10th April onwards Chironomidae invaded the town in large numbers by day and night causing great annoyance. There were many cases of asthma.

1943. No Chironomidae seen in February when the weather was very cold. Many seen in May, and a froth-like scum of pupal skins at the edge of the river. Medical Officer with severe asthma, attributed to midges, removed by air.

1944. On 12th April mosquito-nets were being used to protect people from the annoyance of midges.

1945. Few Chironomidae on 22nd March, apparently because a strong wind had blown for several days. They were said to disappear in April when the hot weather began.

1947. Chironomid season began late, on 25th March, but continued till about June.

1948. Chironomidae appeared very early, on 20th January. Abundant in early April and asthma camp in use. Midges still bad on 3rd May and seen as far inland as asthma camp which was five kilometres from the river. At the hospital 14, out of the permanent staff of 67, were incapacitated by asthma for the whole Chironomid season. The asthma camp had been used yearly from 1943 to 1948. The original patients of 1938 were still the worst sufferers and the number had increased yearly. Asthma had a serious effect on people with colds contracted in the cold weather, and on cases of tuberculosis (M. A. A.). Chironomidae were a serious pest at the Nile Hotel, causing intense annoyance to guests and staff. In the mornings dead midges were swept up by the bucketful. Nearly all lights had to be extinguished in the evenings, many people could not sleep owing to allergic effects, and a considerable proportion of the staff spent periods at the asthma camp. The pest was so bad that the removal of the town was discussed.

1949. Chironomidae became troublesome early in May.

1951. The season began with a few midges on several occasions in the last week of January, especially at river-side houses with gardens, but the season was not a bad one. *T. lewisi* was noticed at the aerodrome by the writer when passing through on 14th April. Professor R. KIRK reported, in the Sudan

Medical Service Annual Report, that asthmatics in the hospital gave a very high proportion of strongly positive reactions when their skins were tested with antigens prepared from *Tanytarsus*.

1952. The season began on 3rd January.

1953. An exceptionally bad season, although Khartoum had a good one.

1954. Few Chironomidae.

Discussion.

Distribution.

There are probably many places on the Nile where Chironomidae are annoying but have not been reported, or where they are abundant but cause little trouble because people live to windward of the river or in villages where there is no vegetation to shelter the midges. Chironomidae are widely distributed in the Sudan, as in most countries, but are only known to become a pest at certain places on the lower Blue and White Niles and the main Nile.

The lake-like conditions of the breeding area.

Some species of *Tanytarsus* abound in European lakes of a certain type for which they have been used as indicators. The finding of *Tanytarsus* in vast numbers in the slowly-moving Nile suggests that an attempt to compare it with these lakes might be instructive, although this must be done with reserve because the Nile is in a different continent and its biology is insufficiently known.

In the dry season the Blue Nile below Karkoj, the White Nile below Renk and the Sudanese section of the main Nile may be likened to a large lake. The Blue Nile near Khartoum for example has the features of the lower courses of certain European rivers, which are listed by ALLEE and SCHMIDT (1951) in comparing them with lakes. The substratum is of mud or fine sand, the current is slow, and there is no coarse suspended sediment. Chironomidae and other bottom inhabitants are largely detritus feeders as on the muddy floors of lakes and ponds; the banks are riddled with the burrows of Ephemerids whose adults are sometimes numerous enough to simulate a snow storm; and Mormyrid fish are found. These conditions are not typical of rivers and comparison with those of a lake is suggested by the slow flow, the length of the channel which allows time for plankton to develop, and the presence of a considerable amount of plankton which includes larvae of *Chaoborus*.

The Nile is rather like a lake in the dry season partly because it is very long and is subject to a climate of the monsoon type with a very long dry season. The great volume of the Blue Nile flood gives this river and the main Nile a broad deep channel along the

bottom of which flows the reduced dry-season stream in a series of placid reaches with some rapids in the north.

European lakes have been grouped into various types for which Chironomidae have been used as indicators, although this is seldom done nowadays (MACDONALD, 1953). Two of the principal types, the oligotrophic and the eutrophic, are discussed by ALLEE and SCHMIDT (1951), BRUNDIN (1949, pp. 873, 880; 1951), CARPENTER (1928), GOETGHEBUER (1928), HUMPHRIES (1938), KRÜGER (1938), THIENEMANN (1950, 1954), and WESENBURG-LUND (1943). Oligotrophic or *Tanytarsus* lakes, characterized by certain species of this genus, are deep and clear, with a narrow littoral zone, and contain little dissolved organic matter or sediment of vegetable origin. The oxygen content is high and in deep water does not fall below 70 per cent. of saturation owing to the presence of green algae down to considerable depths. Eutrophic or *Chironomus* lakes are characterized by numerous big red larvae of this genus whose blood contains dissolved haemoglobin or a related substance. They are typical mud dwellers, some of which can burrow 40 centimetres below the surface of the mud. These lakes are rich in organic matter from decaying plants, and blue-green algae are abundant. In the words of BRUNDIN (1951), "Whereas lakes with a hypolimnion rich in oxygen are characterized by a polyoxybiontic *Tanytarsus* fauna rich in species, lakes with a hypolimnion poor in oxygen show a euryoxybiontic *Chironomus* fauna poor in species".

The Sennar and Jebel Auliya reservoirs have extensive shallow weedy areas but much of the vegetation is removed by grazing when the reservoirs are empty. BROOK and RZÓSKA (1954) have shown that plankton and oxygen increase in the Jebel Auliya Reservoir near the dam, and that below the dam the phytoplankton is like that of a eutrophic lake.

Below the reservoirs the Nile somewhat resembles an oligotrophic lake in having a muddy or sandy bottom and no weedy littoral zone. Between Atbara and Wadi Halfa it is aerated by many rapids.

The clarity and movement of the Blue Nile near Khartoum doubtless contribute to the oxygenation of the water near the bottom. The oxygen content of the river increases in February when the phytoplankton is at its maximum (University College, 1954). BROOK showed that the Blue Nile phytoplankton, when fully developed, is like that of a typical eutropic lake and consists of blue-green algae and diatoms, although at times Chlorococcales are conspicuous.

Chironomus is conspicuous by its absence among pupae from the Nile at Khartoum and many thousands of adult midges taken at light near the river. In March *Nilodorum brevibucca,* a large

midge with a red larva, becomes common at Khartoum, and was particularly abundant in 1953 when the Blue Nile discharge was small. It seemed possible that the opening of the Jebel Auliya dam in February might favour this species by raising the Blue Nile level and reducing the current, and perhaps creating oxygen stratification comparable with that of a eutrophic lake. This kind of effect was observed by BERG (1943) in a European river. Oxygen estimations in Nile water, however, have not revealed any such effect, and *N. brevibucca* or a similar species has been found in numbers at Wad Medani in April. It seems that the whole river may become suitable for this midge, possibly owing to the effect of the summer temperature on the oxygen content.

The Aswan reservoir is considered by ABDIN (1948) to constitute a lake of the eutrophic type.

One may conclude that the main Chironomid breeding area of the northern Sudan can be likened to a lake, and that—as far as comparison with European lakes is at present practicable—it has some resemblance to the oligotrophic but more to the eutrophic type. The lake-like conditions explain why Chironomidae are common but not why *Tanytarsus* predominates.

Some effects of dams on the flow of the Nile.

Before discussing the possible causes of the Chironomid outbreaks it is necessary to consider some changes brought about by dams.

The hydrology of the Nile has been described in great detail in numerous publications of the Egyptian Ministry of Public Works, and the following paragraphs are a brief account of some events which may have affected the Chironomid fauna. Some changes are shown in figure 2 in which the gauge readings are shown in metres above the zero of each gauge. The zero values, in metres above mean sea level at Alexandria, are: Roseires, 426.21 (related to Khartoum); Khartoum, 360.00; Wadi Halfa, 114.05.

Since mid-1925 the Sennar dam has been used for diverting some of the water of the Blue Nile into the Gezira main irrigation canal from July till April and for storing water in October after the flood for release during the succeeding dry season. The dam has created a seasonal lake 354 km. above Khartoum and—by removing water for the canal—has reduced the natural winter discharge of the river at Khartoum. This reduction amounts to some seven million cubic metres of water a day in November and December, the beginning of the Chironomid season. Figure 2 shows the reduced average January discharge since 1926 in contrast to the natural flow above the dam at Roseires. It should be noted that the dry-

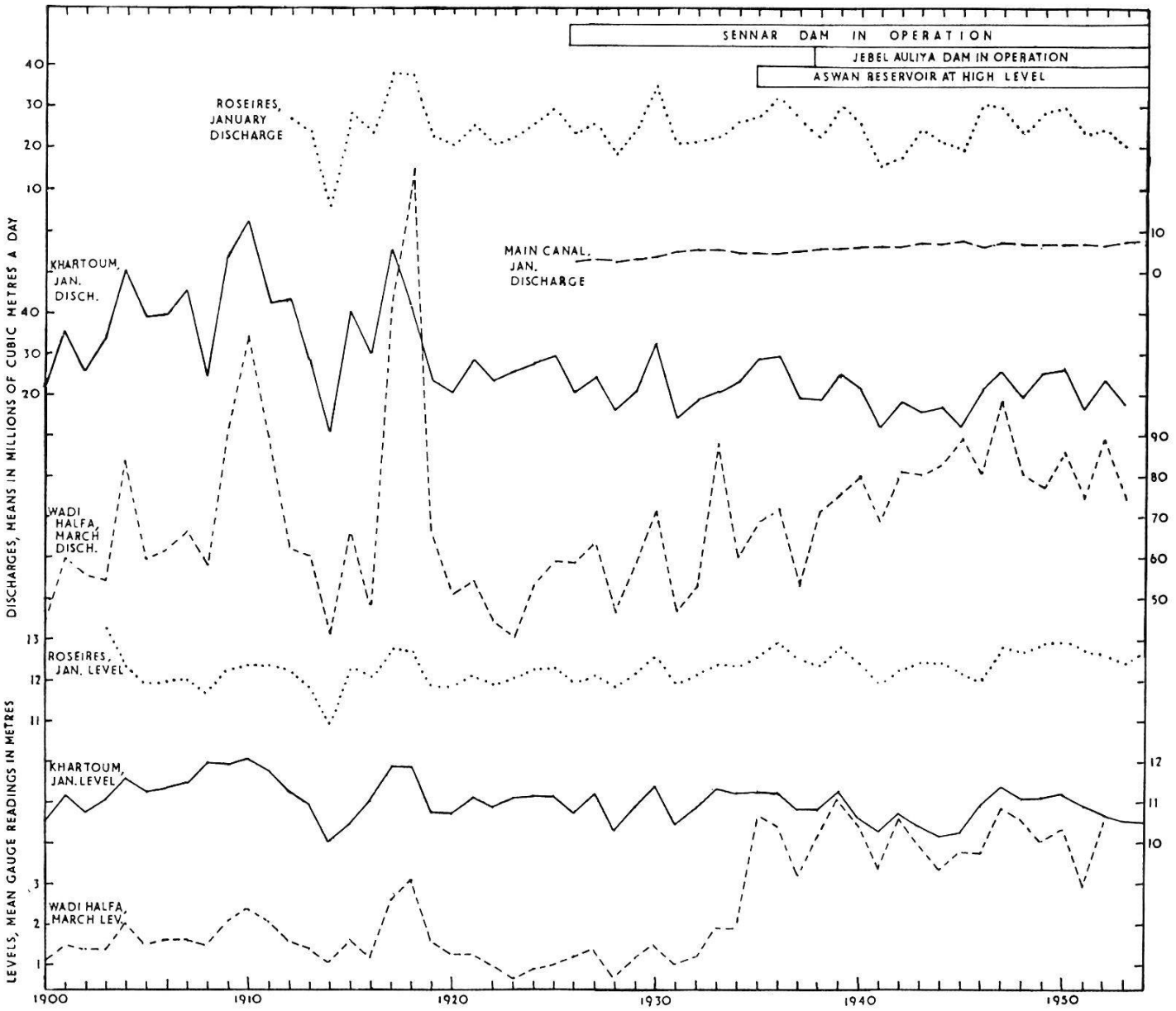

Fig. 2. Showing some discharges and levels of the Blue and main Niles in recent decades.

season level of the Blue Nile at Khartoum is mainly controlled, not by its own discharge, but by the ponding effect of the White Nile, and that gauge readings in some places can be affected by scouring or silting of the river bed.

The Jebel Auliya dam on the White Nile began to operate in 1937 and in 1942 the reservoir was filled to its present working capacity. It begins to store water in July and affects the river for over 400 km. upstream, forming a large lake which lasts until February.

The second heightening of the Aswan dam was completed in 1933 and the reservoir was raised to its full height in 1935 and extended to a point in the cataract above Wadi Halfa. From then onwards the water level there in the winter was considerably higher than its natural level (fig. 2 and LEWIS' fig. 2, 1944).

Possible causes of the outbreaks.

The winter of 1925-1926 was the first in which the Sennar dam was operating, and Chironomidae have been a pest in Khartoum since 1927 (and possibly 1926 but there are no records of this). It is reasonably certain that the dam indirectly caused the outbreaks but it is not easy to say how it did so.

According to RZÓSKA and others (1955) the Sennar reservoir probably acts as a breeding ground for plankton from November onwards, and there is some indication that the Blue Nile plankton has increased since the dam was built. Possibly Chironomidae also increase in the reservoir and their larvae drift towards Khartoum. Adult *Chaoborus* have been seen at Khartoum in September and many *T. lewisi* as early as 23rd October. They are unlikely to have bred in the muddy floodwater of the Blue Nile below the dam and may have come from parts of the reservoir which are clear even during the flood.

The slower average flow of the Blue Nile since 1926 may have improved breeding conditions. It has accentuated the ponding effect of the Blue Nile by the White at Khartoum and may have thus allowed drifting pupae to accumulate and so increase the adult emergence rate at Khartoum, like a road-traffic block causing a stream of vehicles to concentrate at one point. The fact that 1953 was a good year at Khartoum and a bad one at Wadi Halfa and Wad Medani is interesting but cannot at present be explained. Possibly the slow current improved breeding conditions generally but caused many Chironomidae to emerge above Khartoum instead of drifting down to the town. Alleged worse midge years since about 1940 coincided with unnaturally high February and March levels of the Blue Nile caused by the release of water from Jebel Auliya, but it is not known if these provide an explanation.

Knowledge of the Blue Nile fish is insufficient to allow any useful comment on the original theory regarding predatory fish.

The trouble caused by Chironomidae at Omdurman may be due to the shelter afforded to midges by trees which have been planted in recent years.

The Aswan dam may have been a partial cause of the Chironomid outbreaks at Wadi Halfa by creating lake-like conditions favouring the accumulation of larvae and pupae. Other possible causes must be considered however, because three years elapsed between the raising of the reservoir and the first reported midge outbreak, and because pupae presumably drift down from a part of the Nile unaffected by the reservoir. The first outbreak, in 1938, coincided with the first complete year of operation of the Jebel Auliya dam, and it is conceivable that this distant reservoir has

acted as a breeding area for Chironomid larvae which either drifted to Wadi Halfa or to a nearer part of the main Nile where they increased the general Chironomid population of the river. The Jebel Auliya dam passes water to the Aswan reservoir for storage in March and thereby increases the flow of the main Nile (fig. 2). This must accelerate the passage of larvae down the river and may have been a contributary cause of the outbreaks.

The time and duration of Chironomid seasons.

The clarity resulting from the diminution of silt in the Blue Nile after the flood allows microscopic algae to multiply in November and serve as food for Chironomid larvae all along the river, and so probably determines the beginning of the Khartoum midge season. The very hot weather of summer probably ends the season by quickly killing most of the adults.

The midge season at Wadi Halfa usually begins and ends later, possibly owing to the relatively cold long winter in the north.

Annual and daily variations.

At present it is scarcely possible to speculate as to the causes of good and bad Chironomid seasons. The above-mentioned observations at Wad Medani and Khartoum in 1953 suggest that a change in discharge may produce opposite effects at different points on the same river.

The daily effect of wind at Khartoum obscures any variations in the rate of emergence which may occur. Records of sudden appearances of midges at Wadi Halfa suggest that wind may have an important effect there.

Preventive Measures.

Attempts to control Chironomidae at Khartoum will be described in the forthcoming paper mentioned above.

Coarse BHC and DDT dusts have been mixed with water and poured on the surface of shallow still water near the edge of the Nile, so that they sank and lay on the bottom. Many larvae were killed, but complete control of the Chironomidae by anti-larval measures is extremely difficult. It is believed to be possible but only at a great, and perhaps prohibitive, annually-recurring cost. The discharge of the Blue Nile is more than ten million cubic metres a day during the midge season, so that a larvicide designed to permeate the water would have to be used in very large quantities. If a bottom deposit of larvicide were used, it would have to cover a great area because the river bed is very wide, over 500 metres in

some places, and because many larvae and pupae drift down to Khartoum from areas upstream.

Several attempts have been made to kill newly-emerged midges, before they take to the air, by oiling the surface of the river, but this method was only partially successful.

Insecticidal fogs, residual sprays and light-traps have been tried but are unlikely to be practicable on a large enough scale.

It seems at present that the only feasible solution of the problem is for people living near the river to move inland behind a barrier of trees which would prevent the midges from being carried inland by the prevailing north wind. People who must spend their evenings near the river could obtain some relief by clearing nearby vegetation (which shelters the midges), fogging with insecticide, or remaining in rooms fitted with air-filtering equipment.

Acknowledgments.

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References.

ABDIN, G. (1948). Biological productivity of reservoirs with special reference to the Aswan Reservoir (Egypt). — Hydrobiol., *1,* 469-475.

ALLEE, W. C., & SCHMIDT, K. P. (1951). Ecological animal geography. 2nd ed. — New York: Wiley.

BALFOUR, A. (1904). Notes on the tropical diseases common in the Anglo-Egyptian Sudan. — J. trop. Med., *7,* 115-120.

BERG, K. (1943). Physiographical studies on the River Susaa. — Folia Limnol. Scand., no. 1. Copenhagen.

BONNEL, D. E., & MOTE, D. C. (1941). The Klamath Midge. — J. econ. Ent., *34,* 325.

BOWEN, R. (1951). Insects and allergic problems. — South. med. J., *44,* 836-841.

BRAY, G. W., & HURST, A. F. (1934). Recent advances in allergy. — London: Churchill.

BROOK, A. J., & RZÓSKA, J. (1954). The influence of the Gebel Aulia dam on the development of Nile plankton. — J. an. Ecol., *23,* 101-114.

BRUNDIN, L. (1949). Chironomiden und andere Bodentiere der Südschwedischen Urgebirgsseen. — Rept. Inst. Freshwater Res. Drottningholm, *30.*

BRUNDIN, L. (1951). The relation of O_2-microstratification at the mud surface to the ecology of the profundal bottom fauna. — Ibid., *32.*

BUSVINE, J. R. (1951). Insects and Hygiene. — London: Methuen.

CARPENTER, K. E. (1928). Life in inland waters. — London: Sidgwick & Jackson.

DE MEILLON, B., & GRAY, F. C. (1937). The control of a species of *Chironomus* Meigen (Dipt., Chironomidae) in an artificial lake by increasing the salinity. — S. Afr. med. J., pp. 658-660.

EGYPT, MINISTRY OF PUBLIC WORKS. (1933). The Nile basin. III. Ten-day mean and monthly mean gauge readings of the Nile and its tributaries. By H. E. HURST & P. PHILLIPS. Cairo, Gov. Press. (1935, 1939, 1946). Supplements (1933). — IV. Ten-day mean and monthly mean discharges of the Nile and its tributaries. (1933, 1939, 1945). Supplements. (1946). — VII. The future conservation of the Nile. By H. E. HURST, R. P. BLACK, and Y. M. SIMAIKA. (1935-1955). Nile gauge readings (graphs) by the Nile Control General Inspectorate—Hydrological Inspectorate. (1940). The suspended matter in the Nile. By Y. M. SIMAIKA. Schindler's Press. (1944). A short account of the Nile Basin. By H. E. HURST.

FELLTON, H. L. (1940). Control of aquatic midges with notes on the biology of certain species. — J. econ. Ent., *33*, 252-264.

FREEMAN, P. (1950). A species of Chironomid (Diptera) from the Sudan suspected of causing asthma. — Proc. R. ent. Soc. Lond. (B), *19*, 58-59.

GERRY, B. I. (1954). Ecological conditions which influence control of mosquito-like nuisance pests (Tendipedidae). — Mosq. News, *14*, 145-149.

GOETGHEBUER, M. (1928). Faune de France, 18. Diptères (Nématocères) Chironomidae. III. Chironomariae. — Paris: Lechevalier.

GRINDLEY, D. N. (1952). The composition of the body fat of small green chironomids. — J. exp. Biol., *29*, 440-444.

HERMS, W. B. (1950). Medical entomology. — New York.

HUMPHRIES, C. F. (1938). The chironomid fauna of the Grosser Plöner See, the relative density of its members and their emergence period. — Arch. Hydrobiol., *33*, 535-584.

JOHNSON, M. S. (1929). Some observations on chironomid larvae and their usefulness as fish food. — Trans. Amer. Fisheries Soc., *59*, 5 pp.

JOHNSON, M., & MUNGER, F. (1930). Observations on excessive abundance of the midge *Chironomus plumosus* at Lake Pepin. — Ecol., *11*, 110-126.

KAMAL, M. (1948). Biological studies of some midges and their relation to disease transmission, particularly horse-sickness. — Bull. Soc. Fouad I Ent., *32*, 97-121.

KERN, A. (1938). Asthma due to the sensitization to a mushroom fly, *Aphiochaeta (Megaselia) agarici*. — J. Allergy, *9*, 604-606.

KIEFFER, J. J. (1921). Chironomides de l'Afrique Équatoriale (1re Partie). — Ann. Soc. ent. France., *90*, 1-56; (1922). 2e Partie. Ibid., *91*, 1-72; (1923). 3e Partie. Ibid., *92*, 149-204.

KIEFFER, J. J. (1924). Chironomides d'Égypte. — Bull. Soc. R. Ent. Égypte, pp. 244-313.

KRÜGER, F. (1938). *Tanytarsus*-Studien I. — Arch. Hydrobiol., *33*, 208-256.

LEWIS, D. J. (1944). Observations on *Anopheles gambiae* and other mosquitoes at Wadi Halfa. — Trans. R. Soc. trop. Med. Hyg., *38*, 215-225.

LEWIS, D. J. (1955). *Nimitti* and other small annoying flies in the Sudan. — Sudan Notes, *35*, 76-89.

LEWIS, D. J., HENRY, A. J., & GRINDLEY, D. N. (1954). Daily changes in the numbers of Chironomid midges at Khartoum. — Proc. R. ent. Soc. Lond. (A), *29*, 124-128.

LONGSTAFF, G. B. (1911). Three weeks in the Sudan. — Ent. month. Mag., *22*, 119-127, 194-202.

LONGSTAFF, G. B. (1912). Butterfly-hunting in many lands. — London: Longmans, Green.

MACDONALD, W. W. (1953). Lake-flies. — Uganda J., *17,* 124-134.
MALLIS, A. (1954). Handbook of pest control. 2nd ed. — New York: MacNair-Dowland.
MATHESON, R. (1950). Medical Entomology. New York: Comstock.
MUNROE, E. G. (1951). Pest Trichoptera at Fort Erie, Ontario. — Canad. Ent., *83,* 69-72.
ORDMAN, D. (1946). Sewage filter flies *(Psychoda)* as a cause of bronchial asthma. — S. Afr. med. J., pp. 32-35.
RZÓSKA, J., BROOK, A. J., & PROWSE, G. A. (1955). Seasonal plankton development in the White and Blue Nile near Khartoum. — Proc. int. Assoc. theor. appl. Limnol., *12,* 327-334.
SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH (1938). Annual report.
SUDAN MEDICAL SERVICE. Annual reports for 1935, 1937, 1938, 1950-1951 and 1952.
THIENEMANN, A. (1950). Lunzer Chironomiden. — Archiv. Hydrobiol., Suppl., vol. 18.
THIENEMANN, A. (1954). *Chironomus.* Die Binnengewässer, *20.* — Stuttgart: Nägele.
UNIVERSITY COLLEGE OF KHARTOUM (1954). First annual report of the Hydrobiological Research Unit.
WESENBURG-LUND, C. (1943). Biologie der Süsswasserinsekten. — Copenhagen: Springer.

Résumé.

La publication débute par quelques données historiques concernant l'apparition en masse de Chironomides au Soudan.

A Khartoum ces insectes se font remarquer fort désagréablement presque chaque année depuis 1927, généralement en novembre et décembre ou en mars-avril. Leur apparition sous forme d'énormes essaims ne moleste pas seulement la population au plus haut degré, mais peut encore causer de l'asthme et d'autres phénomènes allergiques.

A Wadi Halfa ce fléau a débuté en 1938 ; il commence généralement entre janvier et avril pour se terminer en mai ou juin. Les Chironomes y sont encore plus pénibles à supporter qu'à Khartoum, car ils effectuent leurs vols non seulement le soir, mais aussi durant la journée. On observe à cette époque beaucoup de cas d'asthme qui peuvent prendre des formes tellement aiguës qu'on est obligé d'évacuer certains patients dans un camp spécial situé au désert. Avec des antigènes préparés à partir de *Tanytarsus* le Professeur R. KIRK a obtenu dans des tests cutanés beaucoup de réactions positives.

Le genre *Tanytarsus* est considéré comme forme type pour caractériser hydrobiologiquement certains lacs européens. La présence abondante de *Tanytarsus* dans le Nil stagnant en période sèche nous a amené à comparer ce fleuve avec certains types de lacs en Europe. En tenant compte de toutes les données on arrive à la conclusion que les secteurs du Nil pollués de chironomides en saison sèche peuvent être comparés à un grand lac. Le Nil semble se rapprocher plutôt d'un lac eutrophique dit « *à Chironomides* », qu'à un lac oligotrophique du type *Tanytarsus.*

Sont discutés alors certains changements survenus au cours des dernières décades, provoqués probablement par la construction de barrages et qui sont sans doute responsables pour le fléau des Chironomides. Ainsi leur apparition est très vraisemblablement en rapport avec la construction de la digue de Sennar. A Wadi Halfa les premières invasions de ces moustiques ont été observées trois ans après le second achèvement du réservoir d'Aswan et dans

la première année suivant la mise en fonction du barrage de Jebel Auliya. Plusieurs possibilités sont discutées dans quelle mesure ces digues auraient pu influencer la faune des Chironomides.

L'invasion des Chironomes à Khartoum est évidemment due à un concours de plusieurs circonstances. Lorsqu'un fleuve important, tel que le Nil, traverse un pays à climat de mousson et se trouve en plus être refoulé par un barrage, il présente « en hiver », du point de vue hydrobiologique, des conditions comparables à celles d'un lac. A Khartoum le Nil Bleu est refoulé partiellement par le Nil Blanc. La saison sèche très prononcée ainsi que probablement l'influence de la digue de Sennar, créent des gîtes idéaux et des conditions optima pour que les Chironomides puissent se développer rapidement et avant leurs ennemis prédateurs. La faculté de *Tanytarsus* de pondre des œufs bientôt après l'achèvement de leur métamorphose favorise le développement de ce genre d'insectes, qui forme en effet à Khartoum le gros des essaims de moucherons. La température tropicale accélère le développement larvaire. Durant la période des Chironomes le vent souffle en général en direction de la ville ; beaucoup de maisons sont situées à proximité de l'eau et entourées d'arbres et de buissons servant de refuges aux moustiques. Comme le soleil se couche tôt et que le climat est chaud, la population aime à séjourner dehors après le crépuscule ou à se tenir dans des locaux ouverts ; elle se trouve par ce fait librement exposée aux insectes. Ceux-ci, à cause de leur taille minime, peuvent pénétrer partout.

Pour terminer, l'auteur discute quelques mesures préventives.

Zusammenfassung.

Die Publikation beginnt mit einigen Angaben, welche einen allgemeinen, wenn auch unvollständigen historischen Überblick geben über das erste Auftreten der Chironomiden-Plagen im Sudan.

Seit 1927 machen sich diese Insekten fast jedes Jahr in Khartum äußerst störend bemerkbar, meist im November—Dezember oder im März—April. Das Massenauftreten der Mücken im Bereich des Blauen Nils wirkt sich dann nicht nur äußerst belästigend aus, sondern ist wahrscheinlich auch die Ursache von Asthma und anderen allergischen Erscheinungen unter der Bevölkerung.

In Wadi Halfa setzte die Chironomiden-Plage im Jahre 1938 ein; sie beginnt meistens zwischen Januar und April und endet um den Mai oder Juni herum. Dort sind die Imagines noch lästiger als in Khartum, weil sie oft nicht nur abends, sondern auch tagsüber fliegen. Es werden dann jeweils zahlreiche Asthma-Fälle beobachtet, wobei besonders empfindlich reagierende Patienten sogar in ein spezielles Lager in der Wüste transferiert werden müssen. Professor R. KIRK hat Hautteste mit von *Tanytarsus* gewonnenen Antigenen durchgeführt und erhielt zahlreiche positive Reaktionen.

Die Gattung *Tanytarsus* gilt als Leitform bei der hydrobiologischen Charakterisierung bestimmter europäischer Seen. Das Massenvorkommen von *Tanytarsus* im langsam fließenden Nil während der Trockenzeit hat den Autor dazu bewogen, entsprechende Vergleiche mit europäischen Seentypen anzustellen. Zieht man alle erhältlichen Angaben in Betracht, so kommt man zum Schluß, daß diejenigen Abschnitte des Nils, wo Chironomiden in Massen gedeihen, während der Trockenzeit weitgehend mit einem großen See zu vergleichen sind. Und zwar scheint der Nil eher dem eutrophen, sog. *Chironomiden*-See zu entsprechen als dem oligotrophen *Tanytarsus*-Typ.

Gewisse Veränderungen, die in den letzten Jahrzehnten durch den Bau von Stauwehren hervorgerufen worden sind, werden diskutiert und für die Zunahme der Chironomiden-Populationen und die dadurch verursachten Massenschwärme verantwortlich gemacht. So ist diese Erscheinung in Khartum zeit-

lich mit dem Bau des Sennar-Dammes in Verbindung zu bringen. In Wadi Halfa wurde sie drei Jahre nach der zweiten Errichtung des Aswan-Reservoirs und im ersten Jahr nach der In-Funktion-Setzung des Jebel Auliya-Dammes beobachtet. Es werden verschiedene Möglichkeiten diskutiert, in welcher Weise diese Dämme die Chironomiden-Fauna beeinflußt haben mögen.

Die Chironomiden-Invasion in Khartum ist offenbar auf das Zusammenspiel verschiedener Umstände zurückzuführen. Wenn ein ausgedehnter Flußlauf durch ein Land mit Monsun-artigem Klima fließt und zudem der Stauwirkung eines Wehrs ausgesetzt ist, so bietet er, hydrobiologisch gesehen, im «Winter» seenähnliche Bedingungen. In Khartum wird der Blaue Nil durch den Weißen Nil zum Teil aufgestaut. Die ausgesprochene Trockenzeit und wahrscheinlich auch die Einwirkung des Sennar-Dammes schaffen optimale Brut- und Entwicklungsbedingungen für Chironomiden, und zwar bevor ihre eventuellen Prädatoren aufkommen könnten. Die Fähigkeit von *Tanytarsus*, schon bald nach dem Schlüpfen Eier zu legen, begünstigt diese Gattung, welche denn auch das Gros der Mückenschwärme liefert. Die tropische Temperatur fördert zudem das Larvenwachstum. Während der Chironomidenzeit ist die Hauptwindrichtung nach der Stadt zugewendet, und viele Häuser sind in der Nähe des Wassers gelegen und von Schattenbäumen und Gebüsch umstanden, welche den Mücken Unterschlupf bieten. Infolge des frühen Sonnenuntergangs und des warmen Klimas halten sich die Leute in diesen Breitegraden nach der Dämmerung gerne im Freien oder in offenen Räumen auf und sind deshalb den Insekten ausgesetzt. Wegen ihrer außerordentlichen Kleinheit können die Mücken überall eindringen.

Zum Abschluß werden kurz einige erfolgversprechende Präventivmaßnahmen diskutiert.

Miscellaneum.

Intra-arterial Acetylcholine Injections in the Treatment of Refractory Tropical Ulcers.

By Hans E. A. Meyer (Zürich)
formerly Senior Medical Officer of Kaffa Province (Ethiopia).

The author had under treatment over one hundred tropical ulcers including an appreciable proportion of neglected large phagedenic ulcers penetrating to the bone which showed only a very slight healing tendency. These patients came for treatment at a very late stage with widespread deep ulcers: some of them had already been treated elsewhere for years with native or other medicines and were in a state of very poor nutrition. The patients usually came for hospital treatment for other diseases (malaria, relapsing fever, typhus fever, dysentery, syphilis, etc.). A special building was available for the hospitalization of about 100 cases of tropical ulcer.