CHIRONOMID POPULATION CHANGES IN AN INTERMITTENT WATER SPREADING SYSTEM[1]

ARSHAD ALI AND MIR S. MULLA

Department of Entomology, University of California, Riverside, California 92521

ABSTRACT. Population changes in chironomids in 2 sets of water spreading basins and a flood control channel in the Santa Ana River Basin, southern Calif., were studied from June 1974 to June 1975. Benthic samples from 6 basins (3 of each set) and 4 ponds in the channel, when flooded, were collected biweekly. Water temperature at the time of sampling was recorded.

Larvae of 11 genera were collected. *Tanytarsus* spp., *Chironomus* spp., and *Procladius* spp., in that order, were quantitatively important. *Tanytarsus* spp. predominated in the area from Aug. 1974 to Apr. 1975. *Chironomus* spp. prevailed in large numbers during Oct.–Nov. and Apr.–June. *Procladius* spp. was abundant from June–Sept. The mean density of total larvae in one set of basins was ca. 2000/0.09 m^2 (=ft^2) during Oct.–Nov. 1974 and in May 1975. In the channel ponds the mean density was 1470/0.09 m^2 in Oct.–Nov. and 3000/0.09 m^2 in May–June. These 2 periods seem to experience heavy midge outbreaks.

Intermittent drying and flooding of spreading structures affected the abundance of midges. Areas flooded for long periods and supporting smaller midge numbers prior to drying, invariably supported higher densities when renovated and reflooded. Sharp increases in midge larval densities occured within 2–4 wk after flooding. An increased frequency of drying and flooding of the spreading structures adds to the midge nuisance problem in the vicinity of the water spreading system along the Santa Ana River.

INTRODUCTION.

In some parts of California, underground water is restored by a unique method of holding surface water in shallow spreading structures of percolation. Approximately 300 ha of such a spreading system is present in the Santa Ana River Basin, Orange Co., southern Calif. The river water is intermittently impounded in a number of basins as well as ponds in a flood control channel. These water bodies, ideal sources for profuse breeding of nuisance chironomid midges, are situated amid urban-suburban residential and industrial areas. Adult midges often emerge in phenomenal numbers, causing severe nuisance and economic problems for people working or residing near these aquatic midge habitats.

Systematic studies on the nature, abundance and control of midges in the Santa Ana River Basin were initiated in June 1974, and reported in several papers (Ali and Mulla 1975, 1976ab, 1977). This paper presents information on the qualitative and quantitative composition of the midge fauna, including their abundance, seasonal changes and succession in the various spreading structures. Since these structures are intermittently flooded and dried, the effects of such rapidly changing physical conditions on midge populations were also studied.

MATERIALS AND METHODS

STUDY AREA. The Santa Ana River spreading system, previously described by Ali and Mulla (1976a), extends over an 11-km stretch of Orange Co. and includes a series of more than 20 basins, a flood control channel, and a few large reservoirs. The basins ranging 2–8 ha in surface area and 1–3 m in depth, are arranged in 5 sets. In the topmost set (Imperial Basins), basins are connected with water weirs and are 1–2 m deep, while the other downstream sets have basins connected with conduit pipes and are 1 m deeper than the Imperial basins. The flood control channel running parallel to the basins is ca. 110 m wide and is flooded

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with <1 m deep water. It is divided into 6 sections. Each section contains several "L" shaped ponds with levies built periodically of river sand. The reservoirs are mainly used for storing runoff water coming down the river.

The soil in these spreading structures is porous, consisting primarily of coarse river sand. However, depending upon the duration of water impoundment, silt, clay, sand, and other fine inorganic and organic materials carried by the turbid water, settle out on the underlying sand. Usually 5–10 cm thick layer of fine materials is deposited on the bottom within 2–3 mo after flooding. Since these sediments considerably decrease the rate of water percolation, water supply in various structures is discontinued from time to time. They are then drained, dried, and renovated by scratching or removing the deposited materials.

SAMPLING. Between June 1974 and June 1975, biweekly benthic samples were taken from Imperial basins, Tustin and Glassell basins, and ponds in the flood control channel. Imperial basins 1, 2, and 3, Tustin basins, 1, 3, and Glassell basin, and 4 ponds in the channel, when flooded, were routinely sampled. In the lower 2/3 of each basin, 3 equally spaced sampling stations were established. At each station, one benthic sample from the side and one from the middle area was taken on each visit by the methods previously described (Ali and Mulla 1976b). The channel ponds were also sampled at the sides and middle. Four benthic samples per visit were collected from each pond. Larvae were separated from the bottom sand and mud by the procedures of Mulla et al. (1971) and the samples were counted in the laboratory (Ali and Mulla 1976a).

RESULTS AND DISCUSSION

Larvae of the genera *Procladius* spp., *Pentaneura* sp., *Tanypus* sp., *Psectrotanypus* sp., *Tanytarsus* spp., *Chironomus* spp., *Dicrotendipes* sp., *Polypedilum* sp., *Paralauterborniella* sp., *Tribelos* sp., and *Cricotopus* spp. were collected. Among these, only *Procladius* spp., *Tanytarsus* spp., and *Chironomus* spp. were quantitatively important in the basins as well as in the channel, forming 95–100% of the total monthly collected larvae in Imperial basins, 76–99% in Tustin and Glassell basins, and 88–99% in the channel ponds. The less common genera were: *Dicrotendipes* sp., *Cricotopus* spp., and *Paralauterborniella* sp. *Tanypus* sp. and *Pentaneura* sp. occurred sporadically in small numbers, while *Tribelos* sp., *Polypedilum* sp., and *Psectrotanypus* sp. were occasionally collected. Midge species composition, determined from adults in the area, is given elsewhere (Ali and Mulla 1976a).

Larval trends of *Tanytarsus* spp., *Chironomus* spp., *Procladius* spp., and total chironomids in Imperial basins, and Tustin and Glassell basins are shown in Fig. 1 and 2 respectively, while those in the channel ponds are shown in Fig. 3. These figures also show the time and duration when water supply was discontinued, and the time of renovation and reflooding of the 3 spreading structures.

IMPERIAL BASINS. *Procladius* spp. was the most abundant midge group in Imperial basins from June–Sept., its monthly composition being 79–97% of the total midges (Fig. 1.). This composition, however, changed remarkably in Oct. after renovation and reflooding when *Tanytarsus* spp. dominated with an average density approaching $1700/0.09m^2$ ($=ft^2$) within 3 wk after flooding. *Chironomus* spp. also increased with densities ranging $250–400/0.09m^2$ after 3–5 wk of flooding. Between Oct. 1974 and June 1975, monthly composition of *Tanytarsus* spp. varied from 7–93% of the total larvae. This group formed 73% of the total larvae during Oct.–Feb. After Feb., *Chironomus* spp. dominated, forming 46–90% of the total larvae in the monthly collections (Fig. 1). In May, the density of *Chironomus* spp. was as high as $1800/0.09m^2$. *Procladius* spp. was taken in small numbers during Oct.–June, being rare or absent between Dec. and Feb. Overall, in the entire year, *Procladius* spp. formed

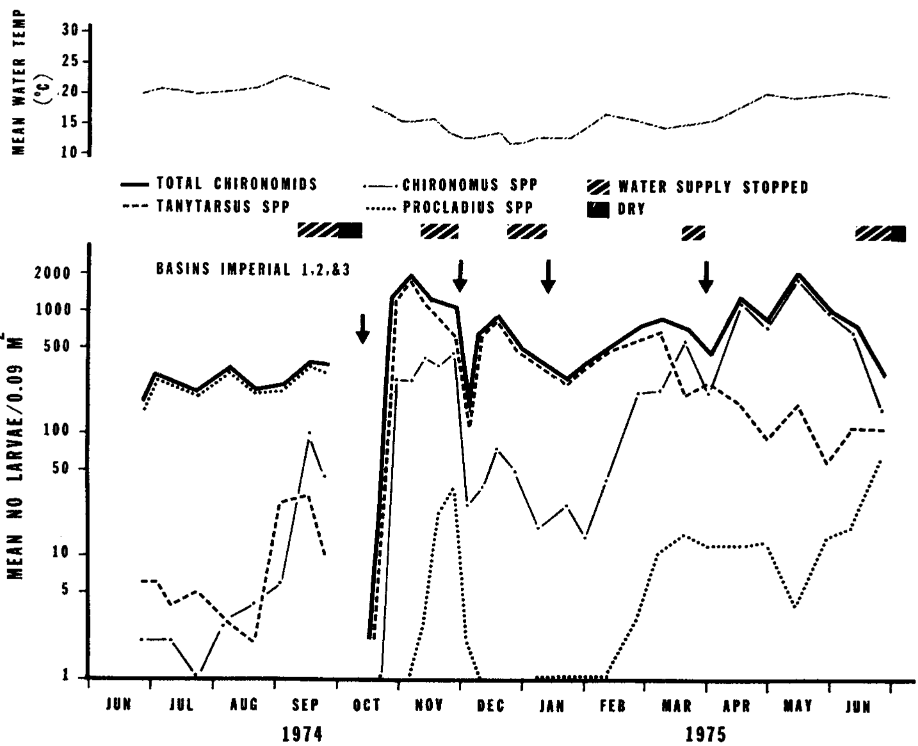

Fig. 1. Population trends of chironomid larvae in water spreading basins (Imperial Basins), Santa Ana River spreading system, Orange Co., Calif. (June 1974–June 1975). Water temperature represents the mean daytime (8 a.m. to 1 p.m.) temperature. Arrows indicate the time of reflooding.

11%, *Tanytarsus* spp. 49%, *Chironomus* spp. 38%, and the other genera 2% of the total midges in Imperial basins. Two peaks were noted during the year, one in Oct.–Nov., and the other in May. Total midge density in each of these peak periods approached 2000/0.09m^2. During the earlier peak, *Tanytarsus* spp. dominated while at the latter, *Chironomus* spp. was predominant.

TUSTIN AND GLASSELL BASINS. In June–July, *Chironomus* spp. and *Procladius* spp. were common in these basins, but after reflooding in July–Aug., *Tanytarsus* spp. appeared in large numbers, predominating for the following 8 mo until Apr. (Fig. 2). Between Aug. 1974 and Apr. 1975, *Tanytarsus* spp. formed 55–84% of the total larvae in the monthly collections. *Chironomus* spp. and *Procladius* spp. were present in very small numbers from Sept. to Jan., each group being 0–2% of the total midges taken monthly, but *Dicrotendipes* sp. was taken in considerable numbers in these months. During Feb.–Apr., *Chironomus* spp. increased and outnumbered *Tanytarsus* spp. in late Apr. *Procladius* spp., although occurring in small numbers, also increased in Mar.–Apr. In mid May when the basins were dried, renovated and reflooded, recolonization occurred rapidly with mean total density approaching 825/0.09m^2 within 12 days after flooding. *Chironomus* spp. predominated for 1–2 wk after flooding, but soom thereafter *Tanytarsus* spp. became equally or more abundant than *Chironomus* spp. Densities of *Procladius*

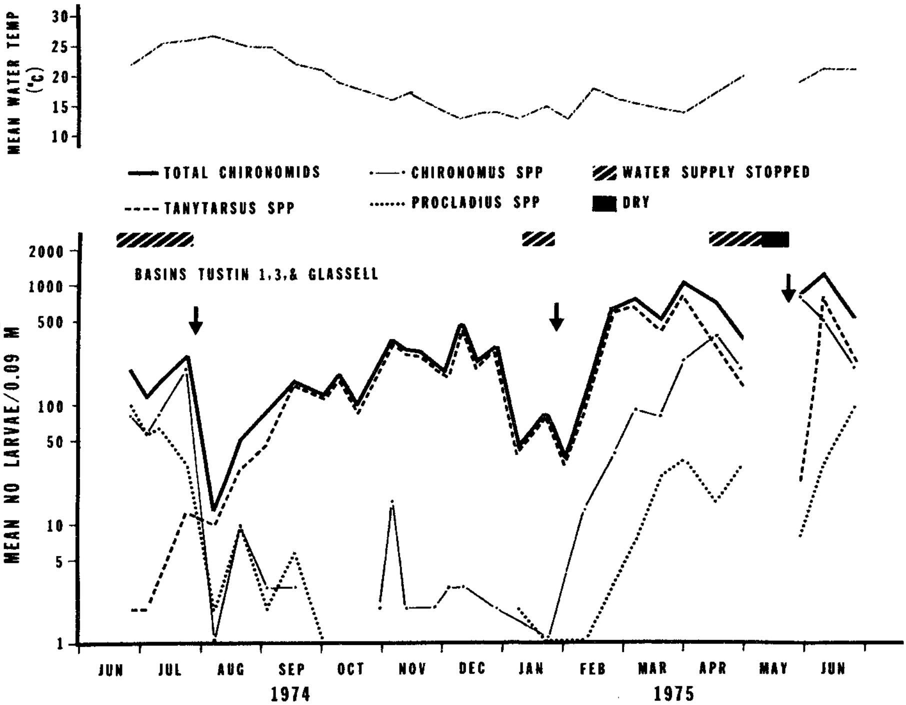

Fig. 2. Population trends of chironomid larvae in water spreading basins (Tustin and Glassell Basins), Santa Ana River spreading system, Orange Co., Calif (June 1974–June 1975). Water temperature represents the mean daytime (8 a.m. to 1 p.m.) temperature. Arrows indicate the time of reflooding.

spp. ranged 9–89/0.09m^2 in May–June 1975. Overall, *Procladius* spp. formed 4%, *Tanytarsus* spp. 56%, *Chironomus* spp. 24%, and the other genera (mostly *Dicrotendipes* sp.) 16% of the total larvae collected from Tustin and Glassell basins in the entire year. Densities of total larvae remained below 600/0.09m^2 from June 1974 to Jan. 1975, increasing thereafter and ranging 650–1300/0.09m^2 from Feb. to June 1975.

Flood Control Channel. In the channel ponds, *Tanytarsus* spp. followed by *Procladius* spp. was the most abundant midge from June to Aug., and after renovation and reflooding in Sept., all 3 common genera numerically increased in these ponds (Fig. 3). *Tanytarsus* spp. dominated in late Oct.–Nov. with an average density exceeding 500/0.09m^2. *Chironomus* spp. was also abundant in Oct.–Nov., its density ranging 40–400/0.09m^2. *Procladius* spp., showing an initial increase after 2–3 wk of flooding declined soon thereafter (Fig. 3). The ponds were again renovated and flooded in early Dec. At this time, *Tanytarsus* spp. was the only genus present until 2 mo post-flooding, predominating until late Apr. *Chironomus* spp., appearing in early Feb., gradually increased in Mar.–Apr., outnumbering *Tanytarsus* spp. in May–June. Densities of *Chironomus* spp. approached 2000/0.09m^2 in May 1975. *Procladius* spp. was absent from Dec. to mid Feb. after which it gradually increased measuring up to 100/0.09m^2 at the end of June. Overall, *Procladius* spp. formed 6%, *Tanytarsus* spp. 54%, *Chironomus* spp. 36%, and the other genera 4% of the total larvae collected from these ponds during the study period. Total larval densities

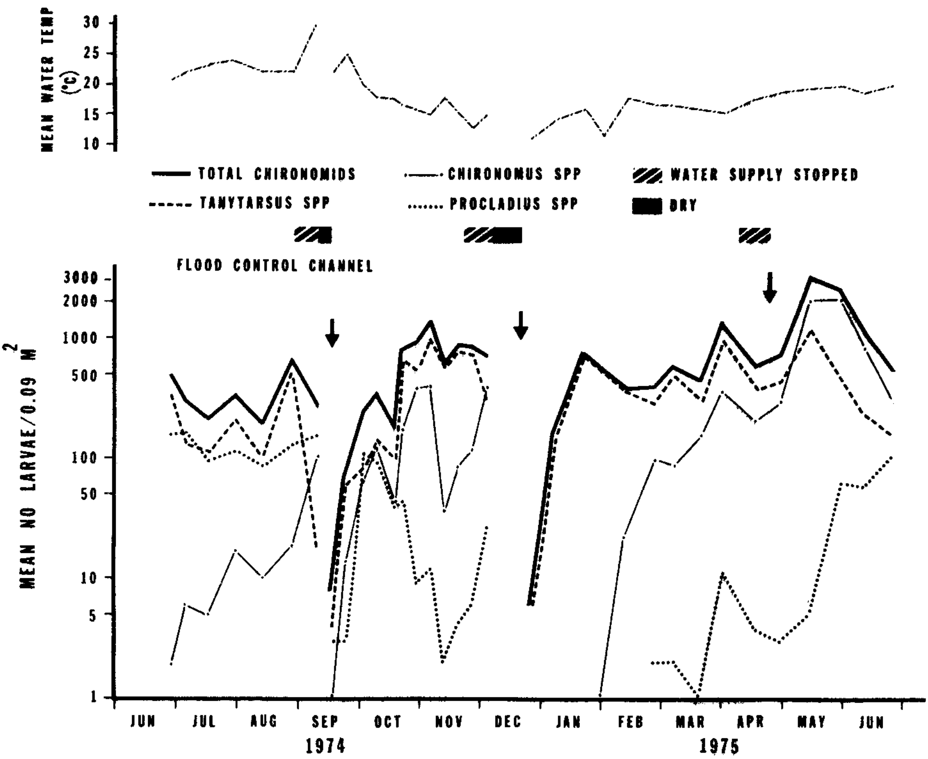

Fig. 3. Population trends of chironomid larvae in ponds in the flood control channel, Santa Ana River spreading system, Orange Co., Calif. (June 1974–June 1975). Water temperature represents the mean daytime (8 a.m. to 1 p.m.) temperature. Arrows indicate the time of reflooding.

remained above 500/0.09m^2 during most months with peaks in Oct.–Nov. (up to 1470/0.09m^2) and in May–June (up to 3000/0.09m^2). At the peak period in Oct.–Nov., *Tanytarsus* spp. dominated, but in May–June, *Chironomus* spp. prevailed.

These studies show that *Tanytarsus* spp., *Chironomus* spp., and *Procladius* spp., in that order, were the 3 most abundant groups of midges in various water spreading structures. *Tanytarsus* spp. were present in large numbers throughout the year, predominating in the area from Aug. 1974 to Apr. 1975, being the most abundant midge group in all spreading structures. *Chironomus* spp. prevailed in large numbers during Oct.–Nov. and Apr.–June. *Procladius* spp. was abundant from June–Sept. During most months, the shallower (<1–m deep) ponds in the channel supported more larvae than the spreading basins, and Imperial basins (1–2 m deep) in turn, supported denser populations than the deeper (1–3 m) Tustin and Glassell basins. This variation in larval densities may have been due to the difference in depth of the 3 spreading structures (Ali and Mulla 1976b), and to their relative serial location in the system, findings concurring with those of Bay et al. (1966) who showed that in a serial arrangement of flood control basins, those at the beginning of a series develop greater midge populations than the ones at the end.

The seasonal changes in stream insect populations are caused by a complex interaction of some intrinsic and extrinsic factors. Temperature is the most obvious factor which affects seasonal cycle and abundance of mayflies and stoneflies in natural lotic systems (Elliott 1967) or chironomids in man-made flood control channels (Ali et al. 1977). The same behavior probably applies to various midge population in the Santa Ana River Basin where abundance of larvae of *Tanytarsus* spp., *Chironomus* spp., and *Procladius* spp. between Apr. and Nov. generally coincided with higher water temperature during these months of the year (Figs. 1–3), although periodic renovation and reflooding interfered with the natural trends. Larval decline from Dec.–Feb. coincided with lower water temperature in the winter months.

These studies also show that intermittent renovation and flooding of the spreading structures have profound effects on abundance of midge fauna. It can be seen from Figs. 1–3 that areas supporting smaller numbers of larvae prior to renovation, invariably supported greater numbers when reflooded (it should be noted that data are plotted on a semi-log scale). Recolonization following renovation and reflooding was faster during the heavy breeding season between May and Oct. (Fig. 1,2) than in Dec. (Fig. 3). In all spreading structures, usually *Tanytarsus* spp. and *Chironomus* spp. appeared and peaked within 2–4 wk after renovation and flooding. This phenomenon of chironomid postflood peaking was also observed by Anderson et al. (1964) in water spreading basins in Montebello, Calif.

The spatial quantitative and qualitative changes in midge populations in different spreading structures in the present study area are governed by numerous factors. Some of these factors are nature and intensity of local oviposition, presence or absence of natural enemies, competition for food and space, and nature and magnitude of drift contribution from upstream areas, with the most important factor being the cycles and durations of water impoundments. With time, the physical and chemical composition of substrate materials and the chemical composition of impounded water gradually change, thus altering midge habitats and in turn the midge composition.

From these studies, it is evident that *Tanytarsus* spp. and *Chironomus* spp. are the 2 most abundant groups of midges prevailing in the various water-spreading structures in the Santa Ana River Basin from Apr.–Nov., the period of midge annoyance in the area. Larval densities increase enormously within 2–4 wk after each renovation and flooding, thus adding to the midge problem. This information, from the management point of view, has a practical significance in this spreading system as well as other similar systems. The frequency of renovation and flooding should be kept to a minimum, especially during the heavy midge breeding and annoyance periods in spring and summer.

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