Studi Trentini di Scienze Naturali, 97 (2018): 17-21

Studi Trentini di Scienze Naturali
ISSN 2532-7712
homepage: http://www.muse.it/it/Editoria-Muse/Studi-Trentini-Scienze-Naturali/Pagine/home.aspx

Article

Adult emergence of the nuisance chironomid *Chironomus salinarius* Kieffer in two Italian lagoons along the northern coast of the Adriatic Sea*

Uberto Ferrarese[1*], Giuseppe Ceretti[2], Giorgio Mattassi[3], Federico Grim[2], Tommaso Ferrarese[4]

[1] Fondazione Museo Civico di Rovereto, Borgo S. Caterina 41, 38068 Rovereto (TN), Italy
[2] Studio Associato Dalla Pozza Ceretti Grim, Via Santa Fosca 13, 34151 Trieste, Italy
[3] Via Stella 76, 33053 Latisana (UD), Italy
[4] Via D. Campagnola 15, 35137 Padova, Italy

Key words

- seasonal emergence
- brackish water lagoons
- Venice, Marano (Italia)

Parole chiave

- sfarfallamento o stagionale
- lagune salmastre
- Venezia, Marano (Italy)

* Corresponding author:
e-mail: *uberto.ferrarese@gmail.com*

Summary

During the1980s and early 1990s swarms of the chironomid midge *Chironomus salinarius* caused nuisance in lagoons of Venice and Marano, along the northern coast of the Adriatic Sea. The surveys carried out since 1983 aimed to assess the distribution of *C. salinarius*, the effectiveness of different larvicide-insecticides against this species, and aspects of its behaviour. To estimate the number of emerged individuals of *C. salinarius* and its seasonal variation, in 1989 and 1990 researches were carried out in two sampling sites of the Venice lagoon (site A and site B), and in one of the Marano lagoon (site C) by means of four emergence traps per site. The two surveys lasted from the 16th to the 42nd week in 1990, while in the Marano lagoon in 1989 it started from the 29th week. The specimens number of *C. salinarius* collected in site C was always higher than those of A and B. The seasonal emergence trends suggest that similar temperature in all the three sites produced four *C. salinarius* generations a year. The environmental conditions that may have produced the different *C. salinarius* population size in the two lagoons are suggested and discussed in the final part.

Riassunto

Durante gli anni ottanta e l'inizio dei novanta del secolo scorso sciami di *Chironomus salinarius* causarono gravi inconvenienti nelle lagune di Venezia e Marano (Nord Adriatico). Scopo delle ricerche condotte a partire dal 1983 era di determinare la distribuzione di *C. salinarius*, aspetti del suo comportamento ed efficacia dei trattamenti contro larve e adulti di questa specie, per ottimizzare gli interventi di controllo. Per ottenere una stima degli adulti sfarfallati nel 1989 e 1990 furono svolte ricerche in due siti di campionamento in laguna di Venezia (sito A e sito B) e in uno in laguna di Marano (sito C) con quattro trappole di sfarfallamento per sito. Le due ricerche durarono dalla 16ma alla 42ma settimana nel 1990, mentre nella sola laguna di Marano nel 1989 la ricerca cominciò nella 29ma settimana. Il numero di esemplari di *C. salinarius* catturati nel sito C risultò sempre maggiore di quelli dei siti A e B. Gli andamenti stagionali delle catture portano a ipotizzare il verificarsi di quattro generazioni annuali. Le condizioni ambientali che possono aver prodotto le differenti popolazioni di *C. salinarius* ipotizzate nelle due lagune sono discusse nella parte finale del lavoro.

* Conference presentation at the 20th International Symposium on Chironomidae, 2-8 July 2017, Trento, Italy

Redazione: Valeria Lencioni e Marco Avanzini

pdf: *http://www.muse.it/it/Editoria-Muse/Studi-Trentini-Scienze-Naturali/Pagine/STSN/STSN_97-2018.aspx*

Ferrarese U., Ceretti G., Mattassi G., Grim F., Ferrarese T., 2018 - Adult emergence of the nuisance chironomid *Chironomus salinarius* Kieffer in two Italian lagoons along the northern coast of the Adriatic Sea. Studi Trentini di Scienze Naturali, 97: 17-21.

Introduction

From the early eighties until the early nineties of the last century an abnormal proliferation of chironomids caused considerable discomfort and economic damage to the inhabitants of some important coastal brackish lagoons of northern (lagoon of Venice, lagoon of Marano and Grado (from now on: lagoon of Marano) and central Italy (lagoon of Orbetello) (Ferrarese & Majori 1985). The problems were particularly conspicuous along the northern coast of the Adriatic Sea, where the first two lagoons are located, going from hindrance to work and free time outdoors activities, including those related to tourism, up to disturbance to land (e.g., vehicle slippage), water (nuisance to boats drivers and passengers both in cabin and boat-wharf) and even air transport (risk of Pitot tube obstruction of aircrafts). In addition, the chironomids entered the houses, creating problems of cleaning and maintenance, and also annoying people.

Since the first collections of 1983 in the lagoon of Venice (Ali et al. 1985; Ceretti et al. 1984), replicated in the following years also in the lagoon of Marano, it was evident that, instead of the occurrence of low numbers of other chironomid species, the only species present in a massive quantity and therefore responsible for the phenomena here briefly described was *Chironomus salinarius* Kieffer, 1915.

The aims of the surveys carried out since 1983 in the two lagoons were meant to determine the distribution and larval densities of *C. salinarius* (Ferrarese & Ceretti 1986), the efficacy of larvicide-insecticides against the same species. (Ali et al. 1985; Ali et al. 1992), to study aspects of its behavior such as the diel emergence (Ferrarese & Ceretti, 1989), or the attractiveness to light (Ali et al. 1994). Also the importance of chironomids in the natural diet of gilthead sea bream of the Venice lagoon, with particular reference to *C. salinarius*, which represented the most numerous species in the gut content of this fish, was studied during this period (Ceretti et al. 1987). On the other hand the survey described in the present paper, carried out in 1989 and 1990, deals with an evaluation of the adults *C. salinarius* emergence in the two mentioned lagoons during the nuisance period. The publication of the results of this research aspect appears to be important to complete the description of this species biology in the cited period and very useful in the adoption and development of methods to counteract its uncontrolled proliferation.

Study area

To value the number of individuals of *C. salinarius* that emerged and its seasonal variation, in 1989 and 1990 research was undertaken at two sampling sites in the Venice lagoon, one North-East of the city between the island of Carbonera and the airport (site A; 45°28'47"N; 12°21'01"E, Figure 1) and the other near the island of Sacca Sessola to the South-West of the city (site B; 45°24'01"N; 12°19'08"E, Figure 1). Site A was an area with a very high larval density of *C. salinarius* (Ali et al. 1985), site B in an area with a slightly lower larval density (Ali et al. 1985). In the lagoon of Marano a sampling site was established 60 m North of the Lignano town cemetery (site C, 45°41'25"N; 13°06'33"E, Figure1), inside an area with a very high larval density (summer range: 1,650-16,700 larvae m^{-2}). All the three areas, including the above cited sampling sites, were characterized by a bottom with macro-algae whose dominant species were *Ulva rigida* C. Agardh, 1823 and *Gracilaria confervoides* (Linnaeus) Greville, 1830.

Materials and Methods

To collect adult chironomids, in each sampling site four pyramidal emergence traps (mod. from Davies, 1980; (Figure 2) with a square basis with a side of 0.5 m were laid on the lagoon bottom. Thus the bottom area covered by the traps in each sampling site was of 1 m^2.

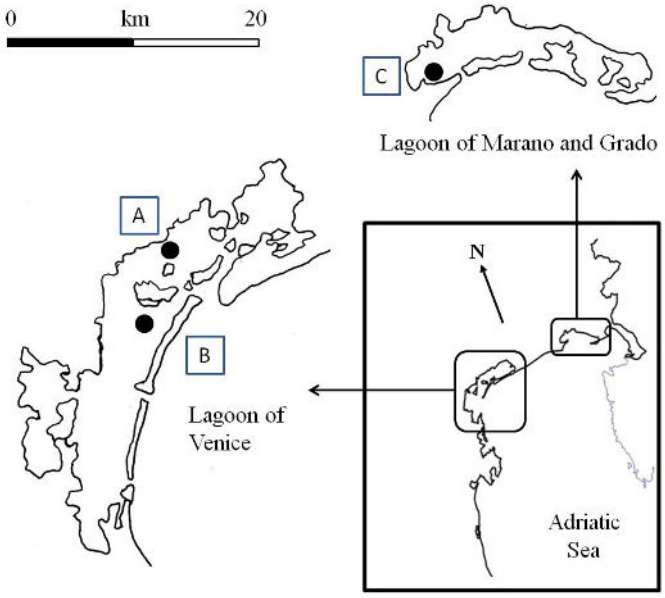

Fig. 1 *- Location of sampling sites in the lagoons of Venice and Marano. / Posizione dei siti di campionamento nelle lagune di Venezia e Marano.*

Fig. 2 *- One of the Davies modified emergence traps employed during the survey. / Trappola di sfarfallamento di tipo Davies modificato usate durante la ricerca.*

In the Venice lagoon the samplings took place from April 17th (16th week) to October 19th (42nd week) in 1989 and from April 17th (16th week) to October 16th (42nd week) in 1990. In the lagoon of Marano the samplings in 1989 began only on July 17th (29th week) and ended on October 19th (42nd week); in 1990 the samplings were held from April 16th (16th week) to October 18th (42nd week). In all sampling sites, two samples of adult chironomids were taken per week. Together with these samples, measures of water temperature, salinity and dissolved oxygen concentration were taken in the Marano lagoon while in the Venice lagoon only water temperature was measured (Table 1).

To estimate the generation number of *C. salinarius* adults in the sampling sites has been used a simplified version of "graphical inflexion" method by Lewis & Taylor (1967), whose different phases are exposed here below. After representing the adults weekly emerged

Tab. 1 - Temperature, salinity and dissolved oxygen concentration ranges registered during the research period in the three sampling sites. / Intervalli di variazione dei valori di temperatura, salinità e ossigeno disciolto misurati nei tre siti di campionamento durante il periodo della ricerca.

	TEMPERATURE (°C)	SALINITY (‰)	OXYGEN (mg l^{-1})
Carbonera (1989)	14 - 30.5	-	-
Carbonera (1990)	12.5 - 28.8	-	-
Sacca Sessola (1989)	13.5 - 30.2	-	-
Sacca Sessola (1990)	13.3 - 29.7	-	-
Lignano (1989)	11.3 - 27.0	3 - 25	1.4 - 13.8
Lignano (1990)	16.6 - 30.0	18 - 33	2.2 - 12.0

frequency distribution by histograms, their cumulative frequency curves have been drawn on probability paper. Some inflexion points have been found out and around their abscissae can be considered the overlapping generation periods. Then idealized and simplified emergence curves have been drawn on the basis of mean, mode, median and standard deviation of each component (i.e., generation) of the distribution. In order to minimize the error, based on curves obtained in this way, an iterative method has been adopted. The values of mean and variance have been varied of a fixed percentage in a neighbourhood of the value previously obtained. For every iteration has been calculated the error with respect to the experimental data and has been chosen the set of values such as to minimize the error itself.

Results

In 1989, 1,454 adult specimens of *C. salinarius* were captured in site A, 753 in site B and 2,455 in site C, while in 1990 649 specimens were captured in site A, 632 in site B and 8,453 in site C. In comparison with the sampling sites A and B (located in the lagoon of Venice) the sampling site C, located in the lagoon of Marano, captured in each of the two years of study a number of adults by far greater (also in 1989, when samplings on this site started in July instead of April). The seasonal pattern of catches in 1989 and 1990 in the three sampling sites is shown in Figures 3, 4 and 5. It shows a common trait in all the three sites, represented by the number of generations that can be determined using the method of the inflections by Lewis and Taylor (1967). This number was clearly four in the two sampling stations (site A and B) of the Venice lagoon (the first in late spring and the others three from summer to early autumn) both in 1989 and 1990 (Figure 3 and Figure 4). Because of the delayed start of the samplings in 1989 in the site C (Figure 5, above) and a very weak generation from late spring and early summer 1990 (Figure 5, below), this number can only be hypothesized for the Marano lagoon.

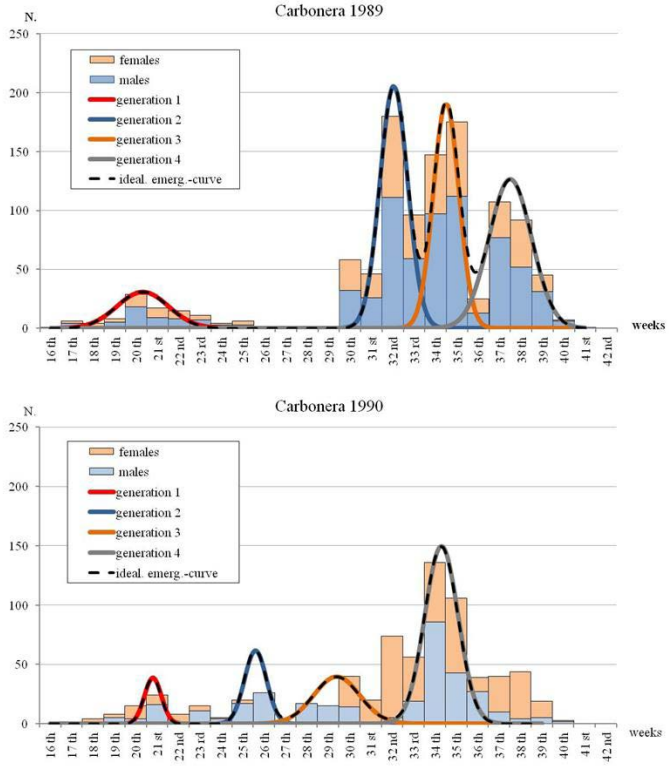

Fig. 3 - Emergence and sex-ratio histograms, idealised emergence-curves obtained from modified inflexion-curve analysis, for C. salinarius in site A in 1989 and 1990. / Istogrammi degli sfarfallamenti e rapporto sessi, curve idealizzate degli sfarfallamenti ottenute mediante analisi modificata del metodo grafico dei flessi per C. salinarius nel site A nel 1989 e 1990.

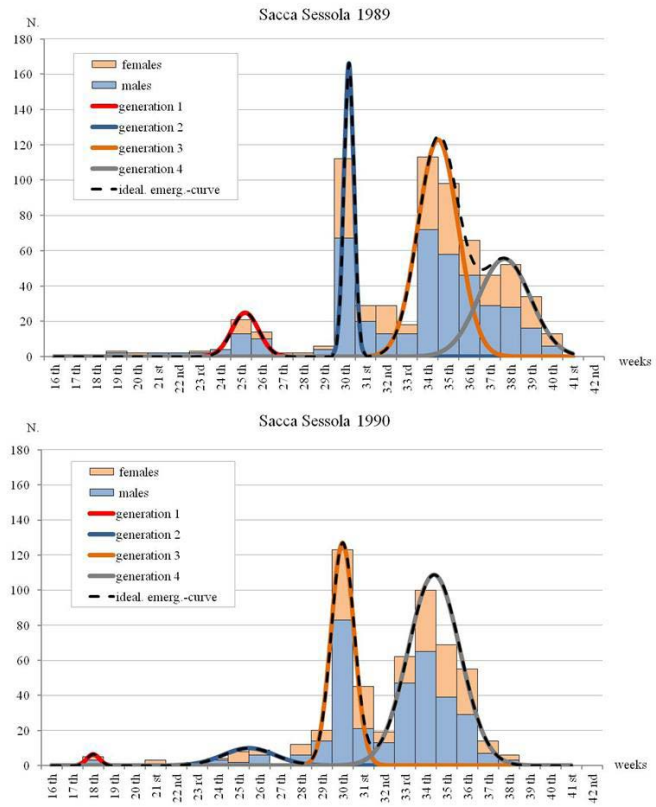

Fig. 4 - Emergence and sex-ratio histograms, idealised emergence-curves obtained from modified inflexion-curve analysis, for C. salinarius in site B in 1989 and 1990. / Istogrammi degli sfarfallamenti e rapporto sessi, curve idealizzate degli sfarfallamenti ottenute mediante analisi modificata del metodo grafico dei flessi per C. salinarius nel site B nel 1989 e 1990.

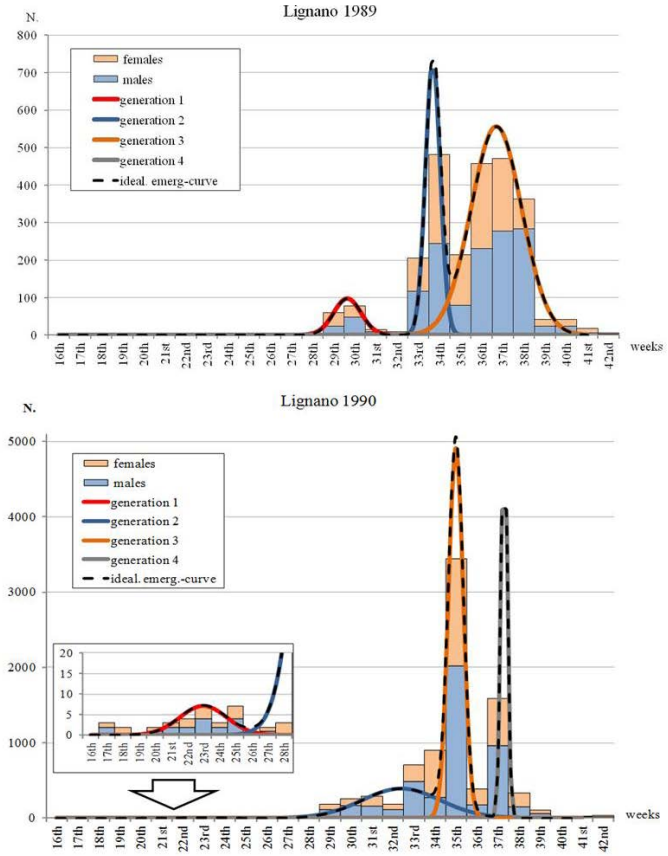

Fig. 5 - Emergence and sex-ratio histograms, idealised emergence-curves obtained from modified inflexion-curve analysis, for C. salinarius in site C in 1989 and 1990. / Istogrammi degli sfarfallamenti e rapporto sessi, curve idealizzate degli sfarfallamenti ottenute mediante analisi modificata del metodo grafico dei flessi per C. salinarius nel site C nel 1989 e 1990.

Discussion

In 1989, as pointed out above, 1,454 specimens of *C. salinarius* were captured in site A, 753 in site B and 2,455 in site C (with a delayed start), while in 1990, 649 specimens were caught in site A, 632 in site B and 8,453 in site C.

The seasonal emergence trends registered in the three sampling sites are represented in Figures 3, 4 and 5. They allow to suggest that, due to similar temperature conditions (Table 1), in all the three sampling sites very likely four *C. salinarius* generations a year occur, one, very reduced in size, in late spring and the others from summer and early autumn. Drake & Arias (1995) hypothesised a probable average of five generations in a lagoon of the Bay of Cádiz, southern Spain, Koskinen (1968) only one near Bergen, Norway and Tourenq (1976) found two main annual emergence peaks in coastal ecosystems in southern France. Thus, as suggested by Huryn (1990), ecosystems with warmer temperature regimes appear to have higher voltinism.

As far as the number of captured individuals is concerned, the registered differences between the sampling sites located in the lagoon of Venice (site A and B) and the one located in the lagoon of Marano (site C), with values always by far lower in the former, are very probably due to the mechanical harvesting of macro-algae carried out since 1987 inside the lagoon of Venice (Solazzi et al. 1991). This practice, reducing algal biomass, including the portion that falls into decay, has effects on the rate of water renewal, on the chemical conditions of the first layers of the lagoon bottom and ultimately on the size of the *C. salinarius* larval population (Solazzi et al. 1991). The result is a reduction in the number of emerging adults of this species. Also Drake & Arias (*loc. cit.*) came to similar conclusions by studying the larval productions of *C. salinarius* of two sampling sites in a lagoon of the Bay of Cádiz with rates of water renewal different from each other.

The main purpose of the macro-algae harvesting was to reduce the degree of "*confinement*" (Guelorget & Perthuisot 1983) of certain parts of the lagoon; it also had the effect of reducing the size of the population of *C. salinarius* (Solazzi et al. *loc. cit.*). Thus it can be added to the list of physical and cultural chironomid control methods, drawn up by Ali (1990, 1995), of which a quick review is made in the following. For very large lagoons such as those of Venice and Marano, these methods mainly concern two aspects of the behavior of adult chironomids: the attraction to light and the diel eclosion times. Unlike mosquitoes, the majority of which respond to the quality of light (i.e., specific color or wavelength in the electromagnetic spectrum, (Ali et al. 1989), chironomids respond to the quantity (power or intensity) of light (Ali et. al. 1984, 1994). This behavior was exploited in the lagoon of Venice by systems of diversion of chironomids, using lights with attenuated intensity in inhabited areas and high intensity ones in little or no inhabited zones, and in addition by placing a series of illuminated white panels around the inhabited islands, along the side of the airport in contact with the lagoon and also on floating barges, moved as needed in the lagoon itself, where suitable control measures, including chemical adulticiding, have been implemented (Ferrarese et al. 1990).

Another aspect of adult chironomids behaviour useful for their control is the diel eclosion periodicity (Ali 1980; Ali & Mulla 1979; Ferrarese & Ceretti 1989). The knowledge of this aspect prove useful, because the adulticide treatments can be synchronized with the timing of adult emergence, striking the adults midges at the moment of maximum vulnerability to the insecticides.

It is not the subject of this work the review of possible chemical or biological methods, which are topics of numerous researches by important authors, carried out, listed and discussed for instance by Ali (1995) himself and for the Mediterranean lagoons by Sinegre et. al. (1990) in the important reviews mentioned above.

Conclusion

For the reasons above-illustrated the practice of macro-algae harvesting in large brackish water lagoon environments may be proposed in the future also to control possible overpopulations of *C. salinarius* and added to the list of physical and cultural methods against this species, which together with the biological and chemical ones (in laboratory and field studies, either for adult or larval control) have been carried out since the fifties of the past century (see for example the review on the nuisance of midges and its control by Ali 1995 and the paper on chironomid chemical control in the French Mediterranean lagoons by Sinegre et al. 1990).

Moreover the above description of a successful action taken in the past to solve the most problematic situations caused by the massive presence of nuisance chironomids in lagoon areas, like those described in the present paper, allows us to state the importance of having at disposal historical data series to overcome similar situations that may arise in the future. That is the reason why the above reported old data are here proposed for publication.

Aknowledgements

The authors express their sincere gratitude to the municipalities of Venice and Lignano for providing funds for these researches and the former ULSS 16 of Venice and ULSS 8 of Palmanova supporting the organization and logistic work.

References

Ali A., 1980 - Diel adult eclosion periodicity of nuisance chironomid midges of central Florida. *Environmental Entomology,* 9: 365-370.

Ali A., 1990 - *Pestiferous Midges and Their Ccontrol: a World-Wide Perspective*: 17-52. In F. D'Andrea and G. Marchese (eds.): Atti del convegno "Chironomidi, Culicidi, Simulidi. Aspetti sanitari ed ecologici*".* Venezia, 1990. Regione Veneto. ULSS 16. S.I.P. Venezia.

Ali A., 1995 - Nuisance, economic impact and possibilities for control pp. 339-364 . In: Armitage P.D., Cranston P.S., Pinder L.C.V. (eds.), *The Chironomidae. Biology and ecology of non-biting midges.* Chapman & Hall, London.

Ali A. & Mulla M.S., 1979 - Diel periodicity of eclosion of adult chironomid midges in a residential-recreational lake. *Mosquito News,* 39: 360-364.

Ali A, Stafford S.R. & Fowler R.C. -1984. Attraction of adult Chironomidae (Diptera) to incandescent light under laboratory conditions. *Environmental Entomology* 13:1004-1009.

Ali A., Majori G., Ceretti G., D'Andrea F., Scattolin M. & Ferrarese U., 1985 - A chironomid (Diptera: Chironomidae) midge population study and laboratory evaluation of larvicides against midges inhabiting the lagoon of Venice, Italy. *Journal of the American Mosquito Control Associati*on, 1: 63-68.

Ali A.,Nayar J.K., Knight J.W. & Stanley B.H., 1989 - Attraction of Florida mosquitoes (Diptera: Culicidae) to artificial light in the field. *Proceedings of the Californian Mosquito Vector Control Association*, 57: 82-88.l

Ali, A., Barbato L., Ceretti G., Della Sala S., Riso R., Marchese G. and D'Andrea F., 1992 - Efficacy of two temephos formulations against *Chironomus salinarius* (Diptera: Chironomidae) in the saltwater lagoon of Venice, Italy. *Journal of the American Mosquito Control Associati*on, 8: 353-356.

Ali A., Ceretti G., Barbato L., Marchese G., D'Andrea F. & Stanley B., 1994 - Attractions of *Chironomus salinarius* (Diptera: Chironomidae) to artificial light on an island in the saltwater lagoon of Venice, Italy. *Journal of the American Mosquito Control Associati*on, 10: 35-41.

Ceretti G., Ferrarese U. & Scattolin M., 1985 - *I Chironomidi nella laguna di Venezia. Risultati delle ricerche 83-84 e proposte di lotta*. Arsenale Editrice, Venezia: 60 pp.

Ceretti G., Ferrarese U., Francescon A. & Barbaro A., 1987 - Chironomids (Diptera: Chironomidae) in the natural diet of gilthead seabream (*Sparus aurata* L.) farmed in the Venice lagoon. *Entomologica Scandinavica Supplement,* 29: 289-292.

Davies I.J., 1980 - Relationships between dipteran emergence and phytoplankton production in the Experimental Lakes Area, northwestern Ontario. *Canadian Journal of Fisheries and Aquatic Sciences*, 37: 523-533.

Drake P. & Arias A.M., 1995 - Distribution and production of *Chironomus salinarius* (Diptera: Chironomidae) in a shallow coastal lagoon in the Bay of Cádiz. *Hydrobiologia*, 299 (3): 195-206.

Ferrarese U. & Majori G., 1985 - Presenza di Chironomidi (Diptera, Chironomidae) nel territorio urbano: importanza economica e problemi di controllo. Atti dell'Accademia Nazionale Italiana di Entomologia. Rendiconti, Anni XXX - XXXI - XXXII (1981-1982 - 1982-1983 1983-1984). Convegno "Entomologia urbana per la qualità della vita" Milano, 17-18 Maggio 1984: 147-163.

Ferrarese U. & Ceretti G., 1986 - Il problema dei Chironomidi (Diptera, Chironomidae) in laguna di Venezia. *Annali dell'Istituto Superiore di Sanità,* 22 (1): 129-136.

Ferrarese U. & Ceretti G., 1989 - Diel emergence of *Chironomus salinarius* Kieffer (Diptera: Chironomidae) in Venice Lagoon. *Acta Biologica Debrecina Oecologica Hungarica*, 2: 189-194.

Ferrarese U., Ceretti G. & Scattolin M.,1990 - *Conoscenze biologiche sui Chironomidi presenti nel Veneto*: 71-87. In: F. D'Andrea and G. Marchese (eds.): Atti del convegno "Chironomidi, Culicidi, Simulidi. Aspetti sanitari ed ecologici". Venezia, 1990. Regione Veneto.ULSS 16. S.I.P. Venezia.

Guelorget O. & Perthuisot J.P., 1983 - Le domaine paralique. Expressions géologiques, biologiques et économiques du confinement. *Travaux du Laboratoire de Géologie, 16. Presses de l'École Normale Supérieure, Paris*: 1-136.

Huryn A.D.,1990 - Growth and voltinism of lotic midge larvae:patterns across an Appalachian Mountain basin. *Limnology and Oceanography*, 35: 339-351.

Koskinen R., 1968 - Seasonal diel emergence of *Chironomus salinarius* Kieff. (Dipt., Chironomidae) near Bergen, Western Norway. *Annales Zoologici Fennici*, 5: 65-70.

Lewis T. & Taylor L.R., 1967 - *Introduction to Experimental Ecology*. Academic Press Inc., London. XI+401 pp.

Sinegre G., Babinot M., Vigo G., Tourenq J.N., 1990 - Sensibilité de trois especes de *Chironomus* (Diptera) à huit insecticides utilizes en démoustication*. Annales de Limnologie*, 26: 65-71.

Solazzi A., Orel G., Chiozzotto E., Scattolin M., Curiel D., Grim F., Vio E., Aleffi F., Del Piero D. & Vatta P., 1991 - *Le alghe della laguna di Venezia*. Volume I. Arsenale Editrice, Venezia: 119 pp.

Tourenq J.N., 1976 - Recherches écologiques sur les chironomides (Diptera) de Camargue. I Étude faunistique et biogéographique. *Annales de Limnologie*, 12: 17-74.