Journal of Advanced Laboratory Research in Biology
E-ISSN: 0976-7614
Volume 5, Issue 3, July 2014
PP 66-70
https://e-journal.sospublication.co.in

Research Article

# Influence of Ozone content on Light Trapped Trichoptera Species in Central Europe

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**Abstract:** The study deals with the connection between ozone content of air and light trap catch of ten Caddisflies (Trichoptera) species from a Jermy-type light-trap. Five species were collected in connection with the increasing the high values of the ozone content, but decrease were observed in case of four species. The results can be written down with second- or third-degree polynomials. Our results proved that the daily catches were significantly modified by the ozone content of air, expressing the different lengths and intensities of the ozone content. The different form of behaviour, however, is not linked to the taxonomic position. Further testing will be required for fuller explanation of the results.

**Keywords:** Caddisflies, Ozone, Light-Trap.

## 1. Introduction

Summer daytime ozone concentration correlates strongly with temperature. The tropospheric Ozone ($O_3$) concentration has been monitored in Hungary at K-puszta (46°58'N 19°35'E) by the Hungarian Meteorological Service since 1996, with 10 minutes averaged ozone concentration detected. Since 2004 the monitoring system was extended to 10 stations in Budapest and 37 ones in other locations throughout Hungary. The ozone content of the air is usually measured in ppm, ppb, µg or mg units (0.1 ppm $O_3$ by weight = 100 ppb $O_3$ by weight = 200 µg $O_3/m^3$ = 0.2 mg $O_3/m^3$) (Ladányi *et al*., 2012).

Ozone concentration in the summer months – from May until August – is higher than in other months of the year. There are typical daily changes. The ozone content is high from noon to evening and decreases from evening to dawn. It hit its lowest point in the dawn hours and begins to rise again in the early morning. Ozone concentrations in the atmosphere depend also on several meteorological factors (Tiwari *et al*., 2008).

The highest ozone levels occur typically in towns and cities, however, in some situations high ozone content has been measured in locations even hundreds of kilometers far away from the emission sources. Elevated ozone concentration is detected usually in the summer months - from May until August - caused by bright sunshine and high temperature, or sometimes in early spring, mainly in March (Ferenczy, 2012).

Kalabokas and Bartzis (1998), Kalabokas (2002), Kalabokas *et al*., (2000), Papanastasiou *et al*., (2002, 2003) as well as Papanastasiou and Melas (2006) in Greece have studied the daily and monthly ozone content fluctuation. The ozone content is usually higher from noon to evening and decreasing from evening to dawn. It hit its lowest point in the dawn hours and begins to rise again in the early morning. However, according to Juhász *et al*., (2006) the ozone content of the atmosphere is occasionally still significantly high during the night.

The highest concentration of ozone is Maleficent to insects. The study of Kells *et al*., (2001) evaluated the efficacy of ozone as a fumigant to disinfest stored maize. Treatment of 8.9 tonnes of maize with 50 ppm ozone for 3 days resulted in 92–100% mortality of adult Red Flour Beetle, *Tribolium castaneum* (Herbst), adult Maize Weevil, *Sitophilus zeamais* (Motsch.), and larval Indian Meal Moth, *Plodia interpunctella* (Hübner).

Biological effects of ozone have been investigated by Qassem (2006) as an alternative method for grain disinfestations. Ozone at a concentration of $0.07 g/m^3$

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killed adults of Grain Weevil (*Sitophilus granarius* L.), Rice Weevil (*Sitophilus oryzae* L.) and Lesser Grain Borer (*Rhyzopertha dominica* Fabr.) after 5-15 hours of exposure. Adult death of Rice Flour Beetle (*Tribolium confusum* Duv.) and Sawtoothed Grain Beetle (*Oryzaephilus surinamensis* L.) was about 50% after 15-20 hours of exposure. Total adult death of all insect species was made with 1.45g/m$^3$ ozone concentration after one hour of exposure. Valli and Callahan (1968) examinations made with light-traps indicated an inverse relationship between $O_3$ and insect activity. According to Bonjour *et al*., (2011), ozone fumigation has potential for the control of some stored grain insect pests of wheat.

Our earlier results suggest that the flying activity of the Common Cockchafer (*Melolontha melolontha* L.) (Puskás and Nowinszky, 2010), European Corn borer (*Ostrinia nubilalis* Hbn.) (Nowinszky and Puskás, 2011), Scarce Bordered Straw (*Helicoverpa armigera* Hbn.), (Puskás and Nowinszky, 2010), Latticed Heath (*Chiasmia clathrata* L.) and April Beetle (*Rhizotrogus aequinoctialis* Herbst) increase when the ozone content is high. In case of Hebrew Character (*Xestia c-nigrum* L.), we detected the increasing flying activity with increasing ozone concentration up to a certain level of ozone concentration which was followed by a decreasing flying activity (Ladányi *et al*., 2012).

In the our earlier study (Nowinszky *et al.*, 2012) we established that the pheromone trapping of the seven Microlepidoptera species, Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius), Red Midget Moth (*Phyllonorycter corylifoliella* Hübner), Codling Moth (*Cydia pomonella* Linnaeus), Peach Twig Borer (*Anarsia lineatella* Zeller), European Vine Moth (*Lobesia botrana* Denis et Schiffermüller), Oriental Fruit Moth (*Grapholita molesta* Busck) and Plum Fruit Moth (*Grapholita funebrana* Treitschke) are most fruitful when the ozone content of the air is high. By contrast, low ozone values, reduce the successfulness of the catching to a moderate level.

## 2. Materials

We had at our disposal the ozone data registered at K-puszta in the year 2000.

We have downloaded these data (μg/m$^3$) from the website of Norsk Institutt for luftforskning (Norwegian Institute for Air Research (NILU) (http://tarantula.nilu.no/projects/ccc/emepdata.html/). The geographical coordinates of K-puszta are the following: 46° 58’ N and 19° 35’ E. We worked with the ozone data of the time 23 o’clock (GMT).

We collected Caddisflies (Trichoptera) species with a Jermy-type light-trap near the Tisza River at Szolnok (47°10'76"N, 25°11'25"E) in 2000 between 1$^{st}$ June and 30$^{th}$ September. Those species were chosen, which fly to the lamp en masse.

The catching data of Caddisflies species are presented in Table 1.

**Table 1. Catching data of the Trichoptera species of Tisza River at Szolnok.**

| Light trapped species | Number of individuals | Number of nights |
|---|---|---|
| **Ecnomidae** | | |
| *Ecnomus tenellus* Rambur, 1842 | 2193 | 103 |
| **Polycentropodidae** | | |
| *Neureclipsis bimaculata* Linnaeus, 1758 | 1502 | 93 |
| **Hydropsychidae** | | |
| *Hydropsyche contubernalis* McLachlan, 1865 | 11711 | 176 |
| *Hydropsyche bulgaromanorum* Malicky, 1977 | 22508 | 101 |
| **Limnephilidae** | | |
| *Limnephilus affinis* Curtis, 1834 | 707 | 100 |
| *Halesus digitatus* Schrank, 1781 | 1009 | 55 |
| **Leptoceridae** | | |
| *Athripsodes albifrons* Linnaeus, 1758 | 810 | 112 |
| *Ceraclea dissimilis* Stephens, 1836 | 947 | 102 |
| *Oecetis ochracea* Curtis, 1825 | 282 | 81 |
| *Setodes punctatus* Fabricius, 1793 | 1759 | 83 |

## 3. Methods

The light source of the applied Jermy-type light-traps was a 100W normal white light electric bulb hanged under a metal cover (Ø: 1m) at 200cm height above the ground. The traps were operated through every night during the season from April until October (Jermy, 1961).

It is clear that the sizes of the species populations are very different at different sites and time intervals. Therefore, we calculated the dimension-free relative catch (RC) data for each observation site and day. The RC is the quotient of the number of individuals caught in a trap during a sampling time unit (1 night) and the average number of individuals of the same generation caught in the same time unit calculated over the whole experimental area. In case of the expected average individual number, the RC value is 1 (Nowinszky, 2003).

We paired the relative catch values of each species of the ozone data on every day during the collection periods. We arranged the values of the ozone data into classes using the method of Sturges (Odor and Iglói, 1987) and then calculated the average relative catch data related to them within both classes. We demonstrated our results and communicated the equations of the curves and significance levels too.

## 4. Results and Discussion

Our results, including regression equations and significance levels, are displayed in Fig. 1-10.

**Fig. 1. Light-trap catch of *Ecnomus tenellus* Rambur depending on the ozone content of the air (Szolnok, 2000).**

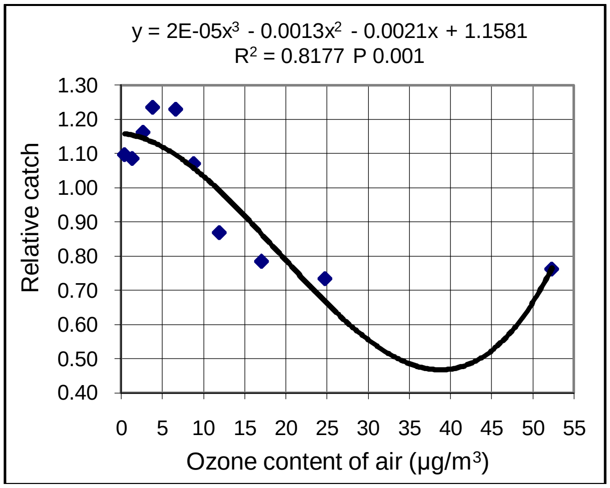



**Fig. 2. Light-trap catch of *Neureclipsis bimaculata* L. depending on the ozone content of the air (Szolnok, 2000).**

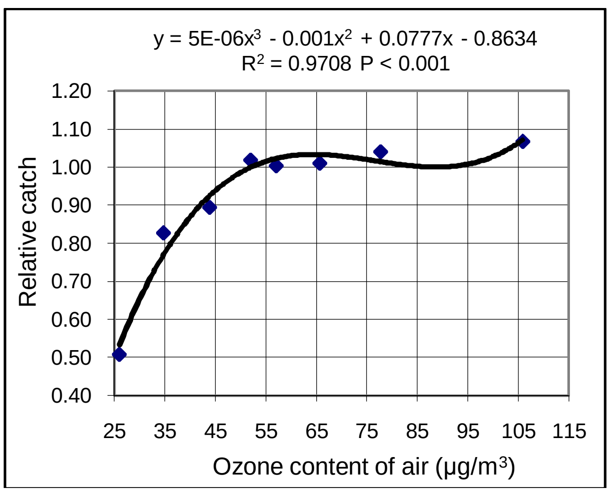



**Fig. 3. Light-trap catch of *Hydropsyche contubernalis* McLachlan depending on the ozone content of the air (Szolnok, 2000).**

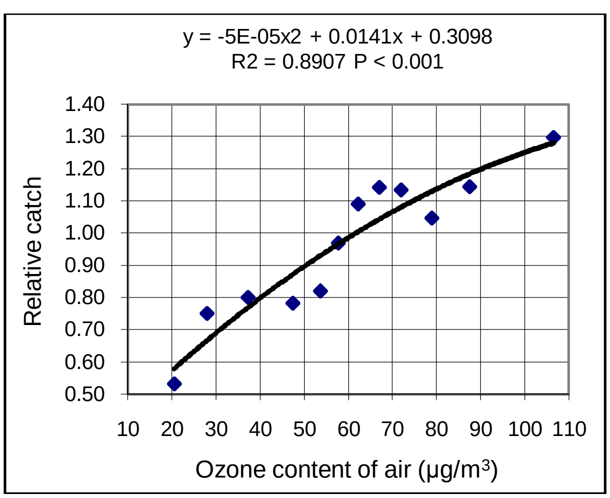



**Fig. 4. Light-trap catch of *Hydropsyche bulgaromanorum* Malicky depending on the ozone content of the air (Szolnok, 2000).**

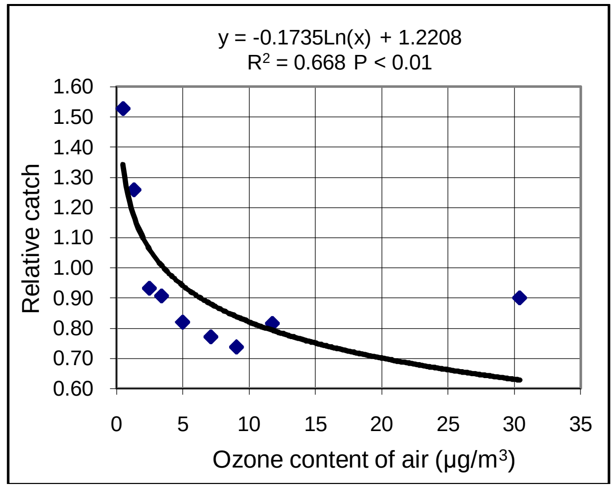



**Fig. 5. Light-trap catch of *Limnephilus affinis* Curtis depending on the ozone content of the air (Szolnok, 2000).**

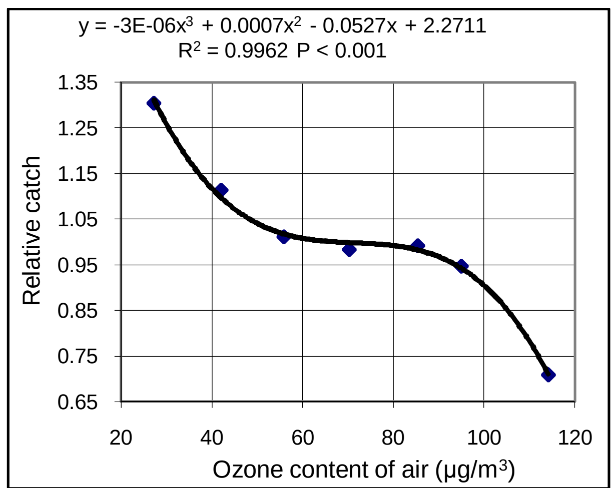



**Fig. 6. Light-trap catch of *Halesus digitatus* Schrank depending on the ozone content of the air (Szolnok, 2000).**

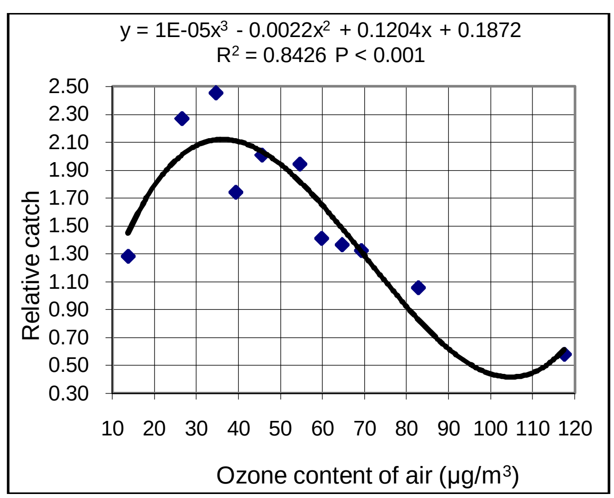


**Fig. 7. Light-trap catch of *Athripsodes albifrons* L. depending on the ozone content of the air (Szolnok, 2000).**

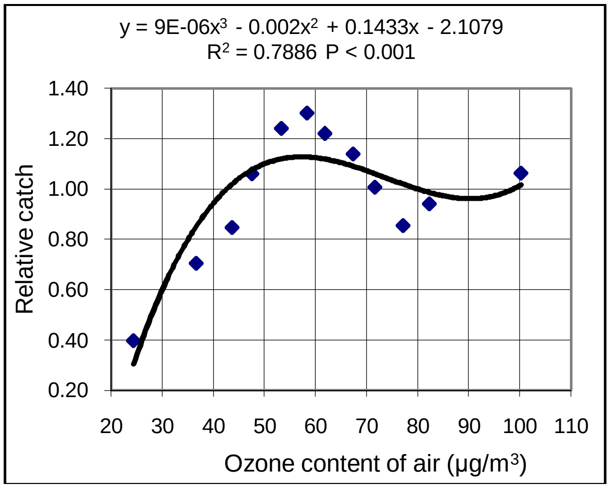



**Fig. 8. Light-trap catch of *Ceraclea dissimilis* Stephens depending on the ozone content of the air (Szolnok, 2000).**

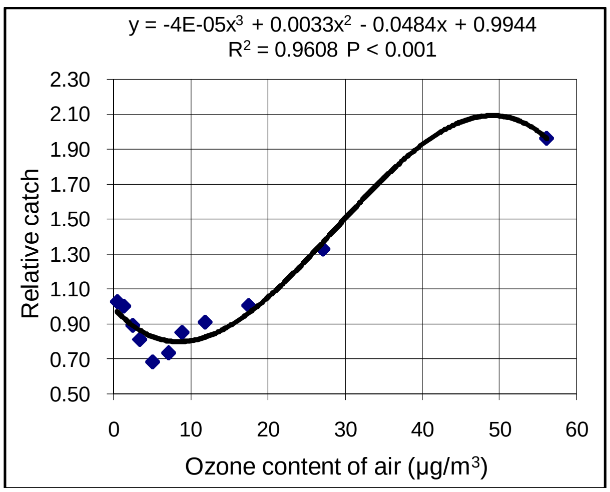



**Fig. 9. Light-trap catch of *Oecetis ochracea* Curtis depending on the ozone content of the air (Szolnok, 2000).**

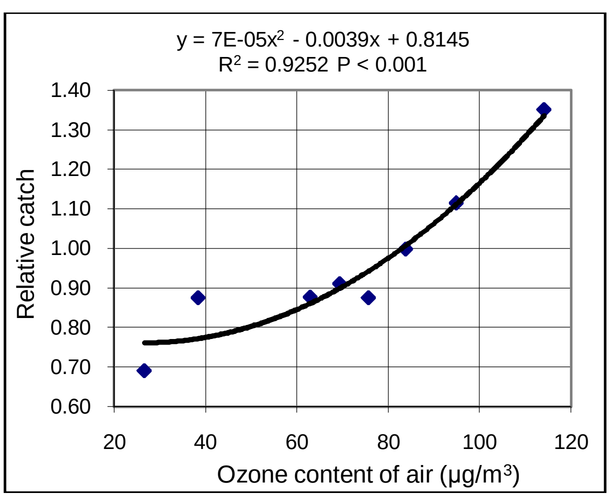
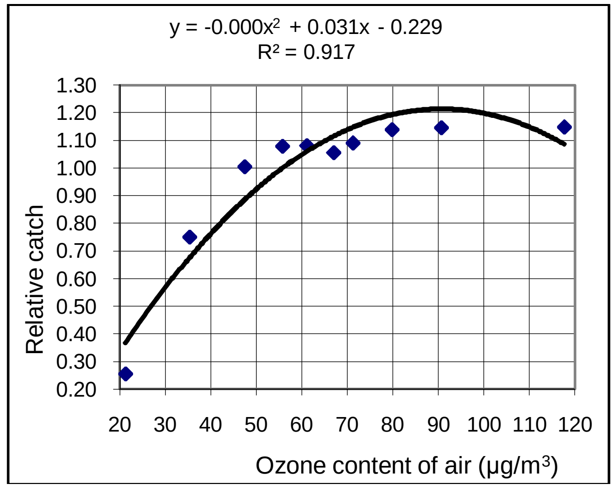



**Fig. 10. Light-trap catch of *Setodes punctatus* Fabricius depending on the ozone content of the air (Szolnok, 2000).**




Our present results suggest that the flying activity of the *Athripsodes albifrons* L., *Neureclipsis bimaculata* L., *Oecetis ochracea* Curtis, *Setodes punctatus* Fabr., *Hydropsyche contubernalis* McLachlan and *Ceraclea dissimilis* Stephens increase when the ozone content is high. Contrarily these flying activities of the *Ecnomus tenellus* Rambur, *Hydropsyche bulgaromanorum* Malicky, *Halesus digitatus* Schrank and the *Limnephilus affinis* Curtis decrease when the ozone content is high. The light-trap catches verify this fact. Low relative catch values always refer to weather situations in which the flight activity of insects diminishes. However, high values are not so clear to interpret. Major environmental -lived, therefore unfavourable weather endangers the survival of not just the individual, but the species as a whole. In our hypothesis, the individual may adopt two kinds of strategies to evade the impacts hindering the normal functioning of its life phenomena. It may either display more liveliness, by increasing the intensity of its flight, copulation and egg-laying activity or take refuge in passivity to weather an unfavourable situation. And so by the present state of our knowledge, we might say that favourable and unfavourable weather situations might equally be accompanied by a high catch (Puskás and Nowinszky, 2003).

As the impact of the tropospheric ozone content on the relative catch of the insects is not widely researched field yet, our observations raise several unsolved problems. It need to be clarified whether the main reasons for the examined phenomenon should be searched in the rate of ozone sensitivity of the species, in the current phonological phase of the insects in which the high ozone content is observed, in the length of time of ozone stress or in other species-specific aspects (Ladányi *et al*., 2012). It is important to investigate the ozone content in the troposphere has increased markedly during the past century, mainly because of the release of nitric oxide, carbon monoxide and gaseous hydrocarbons from vehicles and industrial processes and from the burn of biomass in the tropics (Lelieveld *et al*., 1995).

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