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Sex Ratio Analysis of Some Macrolepidoptera Species Collected by Hungarian Forestry Light Traps

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Abstract – We analysed the sex ratio of 32 macrolepidopteran species caught by Hungarian forestry light traps**.** That the ratio of males and females collected by light trap varies by species has been known for decades; however, the sex ratio found in the natural population is not known. All 32 species were processed separately, but by the same method. Both males and females were counted throughout the whole swarming. We calculated these figures and inspected the difference in the level of significance with the χ^2 test. For each swarming we calculated the percentage of males and females. We also calculated the values of the variation coefficients, which express the deviations in average percentages.

Males make up the majority of the moths captured in the trap; this result was mirrored by 29 of the 32 species investigated. One of the exceptions was the *Pelosia muscerda* Hfn. where we observed a male to female ratio that was equal. In addition to that *Watsoniana cultraria* Fabr. is the only one species captured by light traps that showed a significant female majority.

Our results confirm that the majority of moths captured in traps are males. However, the proportion of males and females of each species, and even within the same species, tended to differ greatly with each swarming. Yet, it must be noted that these results speak only for those specimens captured by light traps and cannot be related directly to the actual sex ratio of populations living in the natural environment.

Macrolepidoptera / sex ratio / forestry light-trap / Hungary

Kivonat – A magyar erdészeti fénycsapdák által gyűjtött néhány macrolepidoptera faj ivar-arányának elemzése. Évtizedek óta ismert, hogy fénycsapdával gyűjtött hímek és nőstények aránya fajonként változik. Nem ismert azonban, hogy milyen a nemek aránya a természetes populációban. 32 fénycsapdával gyűjtött Macrolepidoptera faj hím és nőstény arányát elemeztük**.** Minden fajt külön-külön dolgoztunk fel, de azonos módszerrel. Mind a hímeket, mind nőstényeket megszámoltuk egész rajzás során. Ezeket összeadtuk és az eltérések szignifikancia szintjét χ^2 próbával ellenőriztük. Kiszámítottuk a variációs koefficiens értékeket is, amelyek az eltéréseket az átlag százalékában fejezi ki.

Megállapítottuk, hogy a vizsgált 32 fajból 29 rajzásban magasabb volt a befogott hímek száma, mint a nőstényeké. Kivétel volt a hamvas zuzmószövő (*Pelosia muscerda* Hfn.), amelynél a hím és nőstény arány egyenlő és egyetlen faj bükkfa sarlósszövő (*Watsoniana cultraria* Fabr.), amelynél a nőstények voltak többségben.

Eredményeink szerint a legtöbb faj esetében több a fénycsapdával befogott hím mint nőstény, azonban ez az arány az egyes fajoknál, de még ugyanazon faj, más és más rajzásában is nagyon különböző. Ezek az eredmények azonban nem vonatkoznak közvetlenül a természetben élő populációk valós hím-nőstény arányaira, hanem csak a fénycsapdás fogásokra.

Macrolepidoptera / hím nőstény arány / erdészeti fénycsapda / Magyarország

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1 INTRODUCTION

That the proportion of males and females captured by light trap varies by species has been known for decades; however the sex ratio within the natural population is unknown.

Within the various orders of insects, Williams (1939) studied the sex ratio by species of the specimens caught. Of the 51 species of the Noctuidae family, the females of 2 species were not attracted to light at all. The females of 27 species represented 1–20% of the total number of specimens: this ratio was 20–46% with 16 species: the number of males and females was identical in the case of 3 species and there were only 3 species where more females than males were attracted to light. There is also a behavioural dimorphism: in 2 samples of 37 individuals of ghost moth **(***Hepialus humuli* L.) only 22% males flew to light traps even though sweep net samples gave an approximately 50:50 sex-ratio (Williams 1939). According to Mallet (1984), in the case of *Hepialus humuli* L. more females than males are attracted to light, which suggests that the females are the more mobile gender.

Nanu – König (1968) examined 13 Lepidoptera families to establish the ratio of males and females attracted by light. The females of the various families represented 0.2–30% of the catch. Schurr (1971) captured mostly male specimens of the vine moth (*Eupoecilia ambiguella* Hbn.) with his trap running on white light (of 510–610 nm). Járfás et al. (1974) used different sources of light to study the sex ratio of the turnip moth (*Agrotis segetum* Den. et Schiff.). Whatever the light source, the proportion of males was between 48–66%. Czencz (1973) holds that the males of the diamondback moth (*Plutella xylostella* L.) are more drawn to light than the females (75–25%). She does not provide any explanation for this, however.

Bürgés – Gál (1980), with a 125W mercury light trap, found that with the nut fruit tortrix (*Cydia splendana* Hbn.), males appear 3–4 days earlier than females. The male to female ratio is 1.9:1. This was almost the same as the male to female ratio of the European chestnut weevil (*Curculio elephas* Gyllenhal), which was 1.83:1.

Egyptian Bollworm (*Earias insulana* Boisduval) moths were collected by Yathom (1981) from mercury vapour light traps operating in Israel between 1974 and 1980. He concludes that the sex ratio generally favoured males.

El-Abdullah et al. (1984) report on a mere 10% of the trapped specimens of the Asiatic rice borer (*Cilo suppressalis* Walker) being males. Skuhravý et al. (1993) caught male specimens of the saddle gall midge (*Haplodiplosis marginata* von Roser) almost exclusively, both with a Minnesota-type and a UV light trap.

Itämies et al. (1986) employed a light trap to examine the flight pattern of grey mountain carpet (*Entephria caesiata* Den. et Schiff.) between 1978 and 1982 in the Finnish forest areas of Lapland. With the exception of 1978, males dominated the catch, although this dominance was not overwhelmingly high.

Some researchers have published statements of general validity. Novák (1974) has published sex index data relating to 96 species of moths trapped. Depending on the ratio of females, he arranged the species examined into five classes and, within certain limits, he regarded his results as constant. Malicky (1974) also believes that the sex ratio of a captured species is the same over many years through the use of the same source of light at different places of observation; in other words, sex ratio is value specific to a given species. Szarukán (1975) claims that the average proportion of female specimens of the dog's tooth (*Lacanobia suasa* Schiff.) is 33%. He found minimal difference between the first and second generations. A study in Egypt (Sadek 2001), found that 8.04% of the female mediterranean brocade (*Spodoptera littoralis* Fabr.) specimens that had been trapped had not been fertilized, while the ratios of those fertilized once or more than once were 37.25% and 54.76%. The sex ratio of the sulphur knapweed moth (*Agapeta zoegana* L.) was equal when examined at daytime, but at night the overwhelming majority of the specimens caught by light trap were male. The difference may be explained by the dissimilar reaction of the two sexes to light (Story et al. 2001). In Switzerland Cordillot – Duelli (1986) noticed that the ratio of females captured by light trap in one generation of European corn-borer (*Ostrinia nubilalis* Hb.) was 47.3%. The above mentioned authors regard sex ratio as a static value specific to a species, despite the fact that the annual differences in sex ratio are valuable results related to population changes and not statistical deviation data without a biological value (Szeőke – Szarukán 1982). According to Mohai – Herczig (1979) and also to Lesznyák et al. (1993), the proportion in percentage of females rises and falls in harmony with the rise and fall of the amount of insects caught in light traps. The latter of the abovementioned authors have found that the ratio of females is affected first of all by the minimum values of temperature. El-Deeb (1992) established that the number of European corn-borer (*Ostrinia nubilalis* Hbn.) females captured by light trap surpassed that of the males. However, the ratio was affected positively by maximum and minimum temperature, and negatively by relative vapour content.

Some authors have found that both males and females have to be in a certain physiological state to be attracted to sources of light. Terskov – Kolomiec (1966) report that females of the white satin moth (*Leucoma salicis* L.) can be trapped before egg laying, while those of the gypsy moth (*Lymantria dispar* L.) in Siberia are more prone to be trapped after egg-laying. This latter bit of information is of special interest because there are no data in literature about how gypsy moth females of the European and American populations fly to light considering that the females there are incapable of flight. In contrast to that females of the gypsy moth (*Lymantria dispar* L.) population in East Asia do fly (Wallner et al. 1995; Reineke – Zebitz 1998; Charlton et al. 1999). Females of the European corn-borer (*Ostrinia nubilalis* Hbn.), on the other hand, may fly to light any time following their emergence from the pupal state (Showers et al. 1974). Then again, Elliott – Dirks (1979) claim they are trappable in the largest numbers 3.2 – 4.4 days after mating.

Sathiyanandam – Baskaran (1999) observed that the ratio of females of the groundnut leaf miner (*Aproaerema modicella* Deventer) in India changed during different periods in the night. The ratio of mated to unmated females also changed. The number of males and females of some caddis fly (Trichoptera) species caught by light traps in New Zealand displayed a definite change in swarming. Males were the majority at the start of the swarming, while females made up the majority at the end (Ward et al. 1996). Dickler – Steuerwald (1997) found significant differences from one year to the next in the number of specimens as well as in the sex ratio of noctuids (Noctuidae) captured by light traps in apple orchards in Germany.

In the study of Myers et al. (1998) the sex ratio of gypsy moth (*Lymanrtia dispar* L.) pupae varied strikingly between low-density and high-density populations.

Altermatt et al. (2009) experimentally studied the flight to light behaviour of two moth species – the small ermine moth, *Yponomeuta cagnagella* (Hbn.), and the scorched carpet moth, *Ligdia adustata* (Den. et Schiff.). They found that male moths were significantly more (about 1.6 times more frequently) attracted to light than female moths. It was established that there is a sexual dimorphism in the flight to light behaviour of moths.

Garris – Snyder (2010) investigated and recorded the sex ratio of 28 southern species in the USA. They tested the well-known view that UV light-trap collections of moths are considerably skewed toward males. Twelve species demonstrated a statistically notable male preponderance, but a wide range of sex ratios was found. Two of the 28 species demonstrated significant bias for both males and females during different observation periods, illustrating the need to collect over the entire flight period. Since the sex ratio of collected organisms varies by species and by time, this knowledge must be taken into consideration when using light trap collection to make population estimates and to gather information for conservation or control of any particular species.

According to Tabadkani et al. (2013) appreciation of the proportion of genders of arthropods is a pertinent issue not only in ecological studies and in biological programs, but also in plant protection. In this study, they continued to examine the factors leading to erroneous estimates of sex ratios of insect species. They examined the predatory gall midge, *Aphidoletes aphidimyza* Rondani (Diptera: Cecidomyiidae), and the results explicitly suggest that direct estimation of the sex ratio in natural populations may be affected by some secondary factors such as differential mortality of sexes, protandry, and differential distribution of males and females over time and/or across habitat.

While they could provide us with important, useful information for everyday practice, there are very few publications reporting on research of this kind. Unfortunately, this kind of research is both time consuming and energy consuming; thus, in the foreseeable future, we cannot expect any major breakthrough in this area.

Researchers have been studying the sex ratio of the insects trapped for decades, but their observations had little practical value for plant protection prognostics. The authors of most studies confine themselves to releasing the figures recording the number of males and females, perhaps even their ratio in terms of percentage of the captured specimens, but they refrain from drawing any conclusions. Admittedly, any such attempt would be a vain endeavour, especially in the case of the data provided by light traps operating for short periods. Whereas if the sex ratio of the populations in the environment shifts in the direction of a preponderance of females and that change is reflected in the catch, a growth in the number of the females trapped might indicate the start of gradation. Therefore, awareness of the regularity of sex ratio transformation may also be used for the purposes of prognosis in the case of species where both sexes fly well to light. Some researchers have published general statements concerning this.

When the sex ratio of an observed species at different observation sites and in different years produces decidedly different values, it would be useful to examine regularities in changes. From the point of view of prognosis, the differences in time have main importance, because they might be related to hypercyclic movement. Our own research revealed a rise of the number of turnip moth (*Agrotis segetum* Den. et Schiff.) females in the years which were followed by gradation (in years 1962 and 1968) (Nowinszky – Kiss 1981). It is assumed that the proportion of females affects the number of individuals of future generations. In the year prior to the years of gradation, the number of females increased.

We examined the changes of the number of the females in the turnip moth (*Agrotis segetum* Den. et Schiff.) population between 1957 and 1990. The light-trap catches of 65 observing stations were used (Kiss et al., 2003).

It is concluded that over 99 specimens in each generation the ratio of females is 0.38 from all individual number. If the number of individuals is between 5 and 99, the proportion is 0.44. The proportion of females is 0.46 if the number is between 100 and 499; it is 0.38 between 500 and 999. Between 100 and 999 this value is 0.40. For all observing stations, we calculated the female individual proportions and the 95% confidence intervals for them. We established that higher female proportion belongs to the lower individual numbers, but this proportion is close to the feature if individual numbers are high. It was observed that in the year before gradations begin, the rate of females was extremely high in many cases.

2 MATERIAL

The development of a light trap network began in 1952 in Hungary. The traps were used in research institutes, for plant protection, and for forestry purposes. The three-type light trap network is still working and works with uniformly Jermy-type traps. Over the past decades, the national light-trap network has provided an enormous and inestimable amount of scientific insect material for entomological research and plant protection practice (Nowinszky 2003).

The Jermy-type light trap (Jermy 1961) consists of a frame, a truss, a cover, a light source, a funnel, and a killing device. All the components are painted black, except for the funnel, which is white. A metal ring holding the funnel and a zinc-plated tin joins the steel frame. The cover is 100 cm in diameter. The distance between the lower edge of the cover and the higher edge of the funnel is 20–30 cm. The light source is a 100W normal electric bulb with a colour temperature of 2900°K. The lamp is in the middle of the trussing, 200 cm above ground. The upper diameter of the funnel is 32 cm, while the lower one is 5 cm, and its height is 25 cm. In each case chloroform was used as a killing agent.

The forestry light traps are operational from 6 p.m. (UT) to 4 a.m. every night of the year, regardless of weather, or the time of sunrise and sunset. The operation is suspended only on days when the temperature is below 0 C^{o} and the ground is covered by an unbroken layer of snow. All the insects trapped during the course of a night go into the same collecting jar and so a single set of data will represent the nightly catch result at the given observation site.

In this study we used the catch data of the Hungarian Forestry light trap network of the Forest Research Institute. The light traps were operating in 16 light trap stations across the whole territory of Hungary. The light trap stations, geographic coordinates and years of operation are presented in *Table 1*.

Table 1. The light trap stations, geographic coordinates and years of operation

Light-trap stations	*Geographic coordinates*	*Years of operation*
Budakeszi	47º30′83″N 18º56′03″E	1962–1970
Erdősmecske	46º10′51″N 18º30′80″E	1970
Felsőtárkány	47º58′44″N 20º25′07″E	1961–1970
Gerla	46º42′01″N 21º11′07″E	1962–1970
Gyulaj	46º30′51″N 18º17′76″E	1970
Makkoshotyka	48º21′52″N 21º31′17″E	1961–1970
Mátraháza	47º46′87″N 19º55′69″E	1961–1970
Répáshuta	48º02′90″N 20º31′70″E	1962–1970
Sopron	47º41′01″N 16º34′79″E	1962–1970
Szakonyfalu	46º55′45″N 16º13′71″E	1967–1970
Szentpéterfölde	46º37′02″N 16º45′64″E	1968–1970
Szombathely	47º14′01″N 16º37′22″E	1962–1970
Tolna	46º25′60″N 18º46′95″E	1962–1970
Tompa	46º12′28″N 19º38′08″E	1962–1970
Várgesztes	47º28′52″N 18º23′91″E	1962–1970
Zalaerdőd	47º03′44″N 17º03′30″E	1970

For our study, 32 forest phytophagous Macrolepidoptera species were selected from the national forestry light trap network material dating back to the years between 1961 and 1970.

The species were selected based on data available from several light traps over many years.

Table 2. Catching data of caught species

Families and species	Light-traps	Years	Σ ♂	Σ ♀	χ2 P<
	Number of				
Lasiocampidae					
December Moth *Poecilocampa populi* (Linnaeus, 1758)	2	9	2,817	317	0.01
Autumn Eggar *Eurigaster rimicola* (Denis et Schiffermüler, 1775)	1	9	2,027	40	0.01
Barred Hook-tip *Watsonalla cultraria* (Fabricius, 1775)	3	5	818	1,484	0.01
Scarce Hook-tip *Sabra harpagula* (Esper, 1786)	2	5	888	134	0.01
Thyatiridae					
Popular Lutestring *Tethea or* (Denis et Schiffermüller, 1775)	3	8	2,353	929	0.01
Geometridae					
Maiden's Blush *Cyclophora punctaria* (Linnaeus, 1758)	1	4	1,197	1,331	0.01
Clay Triple-lines *Cyclophora linearia* (Hübner, 1799)	4	7	4,005	4,864	0.01
November Moth *Epirrita dilutata* (Denis et Schiffermüller, 1775)	3	2	1,216	114	0.01
Dingy Shell *Euchoeca nebulata* (Scopoli, 1763)	8	8	2,656	427	0.01
Sharp-angled Peacock *Macaria alternata* (Denis et Schiffermüller, 1775)	5	9	3,018	1,990	0.01
Featheres Thorn *Colotois pennaria* (Linnaeus, 1761)	9	7	4,561	567	0.01
Peppered Moth *Biston betularia* (Linnaeus, 1758)	5	8	4,359	34	0.01
Pale Oak Beauty *Hypomecis punctinalis* (Scopoli, 1763)	9	9	12,715	2,938	0.01
The Engrailed *Ectropis bistortata* (Goeze, 1781)	12	9	17,815	1,517	0.01
Notodontidae					
Buff-tip *Phalera bucephala* (Linnaeus, 1758)	3	4	495	7	0.01
Plumed Prominent *Ptilophora plumigera* (Denis et Schiffermüller, 1775)	1	4	2,118	275	0.01
Small Chocolate-tip *Clostera pigra* (Hufnagel, 1766)	1	10	886	12	0.01
Chocolate-tip *Clostera curtula* (Linnaeus, 1758)	1	10	699	7	0.01

Table 2. Catching data of caught species (continuation)

Families and species	Light-traps	Years	Σ ♂	Σ ♀	χ² P<
	Number of				
Lymantriidae					
Pale Tussock *Calliteara pudibunda* (Linnaeus, 1758)	4	7	1,411	72	0.01
Yellow-tail *Euproctis similis* (Fuessly, 1775)	2	9	540	38	0.01
White Satin Moth *Leucoma salicis* (Linnaeus, 1758)	1	5	157	18	0.01
Arctiidae					
Dotted Footman *Pelosia muscerda* (Hufnagel, 1766)	3	10	1,791	1,762	NS
Scarce Footman *Eilema complana* (Linnaeus, 1758)	6	10	8,244	6,156	0.01
Common Footman *Eilema lurideola* (Zincken, 1817)	5	9	15,980	12,252	0.01
Noctuidae					
Small Quaker *Orthosia cruda* (Denis et Schiffermüller 1775)	5	7	6,820	3,201	0.01
Hebrew Character *Orthosia gothica* (Linnaeus, 1758)	8	9	4,565	727	0.01
The Satellite *Eupsilia transversa* (Hufnagel, 1766)	7	10	2,974	2,911	NS
The Chestnut *Conistra vaccinii* (Linnaeus, 1761)	11	10	11,479	5,428	0.01
Pale-lemon Sallow *Xanthia ocellaris* (Borkhausen, 1792)	3	8	542	886	0.01
The Dun-bar *Cosmia trapezina* (Linnaeus, 1758)	6	8	2,097	1,483	0.01
Lesser Belle *Colobochyla salicalis* (Denis et Schiffermüller, 1775)	2	9	2,056	614	0.01
Jubilee Fan-foot *Zanclognatha lunalis* (Scopoli, 1763)	4	10	12,077	8,234	0.01

The flying period and primary food plants of caught moths are shown in *Table 3.*

3 METHODS

All species were processed separately, but by the same method. The number of captured males and females was counted for the entire swarming. These were summarized and the difference in level of significance was calculated with χ^2 test.

For each swarming we calculated the percentage of males and females. We also calculated the values of the coefficients of variation, which express the deviations in average percentages.

Table 3. The flying period and primary food plants of caught moths

Families and species	*Flying period of moths*	*Primary food plants*
Lasiocampidae		
P. populi L.	October-November	Quercus, Betula, Populus, Tilia
E. rimicola Den. et Schiff.	September-October	Quercus
W. cultraria Fabr.	May-June; July-August	Fagus
S. harpagula Esp.	May-June; July-August	Tilia, Betula, Quercus
Thyatiridae		
T. or Den. et Schiff.	April-May; August	Populus
Geometridae		
C. punctaria L.	April-May; July-August	Quercus, Betula
C. linearia Hbn.	May-June; July-August	Fagus, Quercus, Betukla
E. dilutata Den. et Schiff.	September-November	Quercus, Acer, Betula, Ulmus
E. nebulata Scop.	June-August	Alnus Quercus, Acer, Betula
M. alternata Den. et Schiff.	April-May; July-August	Salix, Alnus, Prunus
C. pennaria L.	September-November	Carpinus, Quercus, Tilia, Salix
B. betularia L.	May-June; July-August	Betula, Ulmus, Salix, Fraxinus
H. punctinalis Scop.	May-July	Quercus, Betula
E. bistortata Gze.	April-May	Polyphagous (Acer, Alnus)
Notodontidae		
Ph. bucephala L.	May-June ; July-August	Quercus, Tilia, Salix
P. plumigera Den. et Schiff.	October-December	Acer, Fagus, Prunus
C. pigra Hfn.	April-June; July-August	Salix
C. curtula L.	April-May; June-August	Populus, Salix
Lymantriidae		
C. pudibunda L.	May-June	Fagus, Carpinus, Ulmus, Tilia,
E. similis Fuesl.	June-July	Qurcus-, Ulmus-, Tilia, Salix
L. salicis L.	June-July	Populus
Arctiidae		
P. muscerda Hfn.	July-August	Lichenes
E .complana L.	July-August	Lichenes
E. lurideola Znck.	July-August	Lichenes
Noctuidae		
O. cruda Den. et Schiff.	March-April	Quercus, Betula, Acer, Carpinus
O. gothica L.	March-April	Quercus, Tilia, Ulmus, Betula
E. transversa Hfn.	September-April	Quercus, Betula
C. vaccinii L.	September-April	Quercus, Betula
X. ocellaris Brkh.	September-April	Quercus, Tilia, Acer, Ulmus,
C. trapezina L.	June-September	Quercus, Fagus, Betula, Acer
C. salicalis Den. et Schiff.	May-August	Populus, Salix
Z. lunalis Scop.	May-September	Fagus

4 RESULTS AND DISCUSSION

The results are shown in *Table 4*.

Table 4. The percentage of males and females, deviations and coefficients of variation.

Families and species	Σ Moths	Mean ♂%	♂s	♂CV	Mean ♀%	♀s	♀CV
Lasiocampidae							
Poecilocampa populi L.	2,134	0.83	0.177	0.21	0.17	0.177	1.04
Eriogaster rimicola Den. et Schiff.	2,067	0.98	0.018	0.02	0.02	0.018	0.90
Drepanidae							
Watsonalla cultraria Fabr.	2,308	0.37	0.111	0.30	0.63	0.106	0.17
Sabra harpagula Esp.	1,022	0.88	0.042	0.05	0.12	0.042	0.37
Thyatiridae							
Tethea or Den. et Schiff.	3,292	0.75	0.092	0.12	0.25	0.106	0.42
Geometridae							
Cyclophora punctaria L.	2,528	0.61	0.179	0.29	0.39	0.179	0.46
Cyclophora linearia Hbn.	8,862	0.48	0.102	0.21	0.52	0.092	0.18
Epirrita dilutata Den. et Schiff.	1,340	0.89	0.040	0.04	0.11	0.034	0.31
Euchoeca nebulata Scop.	3,083	0.86	0.141	0.16	0.12	0.141	1.17
Macaria alternata Den. et Schiff.	5,004	0.75	0.114	0.15	0.25	0.115	0.46
Colotois pennaria L.	5,128	0.91	0.086	0.09	0.09	0.086	0.96
Biston betularia L.	4,393	0.99	0.011	0.01	0.01	0.011	1.10
Hypomecis punctinalis Scop.	15,553	0.88	0.076	0.09	0.12	0.076	0.63
Ectropis bistortata Goeze	19,443	0.97	0.048	0.05	0.03	0.045	1.50
Notodontidae							
Phalera bucephala L.	502	0.98	0.019	0.02	0.02	0.019	0.95
Ptilophora plumigera Den. et Schiff.	2,393	0.90	0.054	0.06	0.10	0.054	0.54
Clostera pigra Hfn.	886	0.99	0.013	0.01	0.01	0.008	0.80
Clostera curtula L.	699	0.99	0.009	0.01	0.01	0.009	0.90
Lymantriidae							
Calliteara pudibunda L.	1,183	0.95	0.039	0.04	0.05	0.039	0.78
Euproctis similis Fuesl.	578	0.94	0.037	0.04	0.06	0.036	0.60
Leucoma salicis L.	175	0.89	0.073	0.08	0.11	0.074	0.67
Arctiidae							
Pelosia muscerda Hfn.	3,553	0.53	0.108	0.20	0.47	0.108	0.23
Eilema complana L.	13,400	0.56	0.129	0.23	0.44	0.129	0.29
Eilema lurideola Zinck.	28,232	0.68	0.174	0.26	0.32	0.174	0.54
Noctuidae							
Orthosia cruda Den. et Schiff.	10,021	0.66	0.105	0.16	0.34	0.105	0.31
Orthosia gothica L.	5,292	0.88	0.071	0.08	0.12	0.071	0.59
Eupsilia transversa Hfn.	5,885	0.51	0.083	0.16	0.49	0.083	0.17
Conistra vaccinii L.	16,907	0.69	0.123	0.18	0.31	0.123	0.40
Xanthia ocellaris Borkh.	1,428	0.39	0.194	0.50	0.61	0.194	0.32
Cosmia trapezina L.	3,580	0.58	0.082	0.14	0.42	0.082	0.19
Colobochyla salicalis Denis et Schiff.	2,670	0.81	0.085	0.10	0.19	0.085	0.45
Zanclognatha lunalis Scop.	20,311	0.62	0.130	0.21	0.38	0.130	0.34

Notes: Mean ♂% and Mean ♀% = averaged percentage of males and females,
♂s and ♀s = deviations, ♂CV and ♀CV = coefficient of variations.

We found the majority of moths collected in light traps are males. This result is true of 29 species from the investigated 32 species. However, the proportion of males and females of each species, and even within the same species, differed greatly during each swarming.

One probable explanation may be the protandry for greater number of males. Cordillot (1989) established that occurrence of the male of the European corn-borer (*Ostrinia numilalis* Hbn.) in the light trap preceded the females' occurrence by 3.8 ± 1.5 days on average. This phenomenon was named "protandry" by Stockel and Peyelut (1984). That the females of some species are attracted to light in greater number after mating may be the cause of this.

Yathom (1981) found the most frequently light trapped Egyptian bollworm (*Earias insulana* Boisduval) females mated once. Lopez et al. (2000) found that the overwhelming majority of the females of *Mythimna unipuncta* (Haworth) flew to light after egg-laying. We also observed the "protandry" phenomenon in the case of the dotted footman *Pelosia muscerda* Hfn. in Tompa 1970; the male and female ratio is equal with this species. Males and females of both species (*Pelosia muscerda* Hfn. and *Eupsilia transverse* Hfn.), are captured nearly in similar number. Cordillot (1989) found that the overall ratio of European corn-borer (*Ostrinia nubilalis* Hbn.) was found almost the same; of the captured moths, 52.7% were males and 47.3% were females.

Watsoniana cultraria Fabr. is the only one species captured by light traps that showed a significant female majority. We examined 8 swarmings; females outnumbered males in 7 of them. The males of this moth also fly in the sunlight and they can usually be seen among the higher branches of beech trees. This may be a reason why fewer males of this species are captured at night.

For decades it has been known that the proportion of male and female individuals of various insect species caught by light trap tends to differ. This fact proves that the ratio of the various species represented the catch are not the same as the ratio that appears in nature (Kiss et al. 2003). The reasons for this fact may be many. Flight is difficult for females because of their increased weight due to developing eggs. The males may be more active as they visit the females with the aim of the mating. It is also possible that the males have a greater affinity to light (Waringer 2003).

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